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Draft Environmental Impact Statement: Henderson, North Carolina 201 Wastewater Treatment System Project No. C-370410

Environmental Protection Agency, Atlanta, Ga Region IV

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10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Address
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Draft EIS

14.

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16. Abstracts

This Draft Environmental Impact Statement (EPA 904/9-76-028) was prepared in response to the action of awarding grant funds to the City of Henderson, N. C. for the purpose of developing a wastewater treatment system to service the Greater Henderson area. The project consists of the necessary facilities to process and treat approximately 3.7 million gallons per day (MGD) of wastewater. Vance, Warren, and Franklin Counties will potentially be affected by the proposed action. Three alternatives systems have been selected for final consideration. A single system will be chosen for implementation after the public and agency review of this draft statement.

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MGD plant

17b. Identifiers/Open-Ended Terms

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DRAFT
ENVIRONMENTAL IMPACT STATEMENT

HENDERSON, NORTH CAROLINA
201 WASTEWATER TREATMENT SYSTEM
PROJECT NO. C-370410

REPRODUCED BY
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UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION IV
345 COURTLAND STREET
ATLANTA, GEORGIA 30308

DRAFT ENVIRONMENTAL IMPACT STATEMENT

Henderson, North Carolina
201 Wastewater Treatment System
Project No. C-370410

Environmental Protection Agency
Region IV
345 Courtland Street
Atlanta, Georgia 30308

Approved:

Jack E Ravan
Regional Administrator

11/8/76
Date

SUMMARY SHEET FOR ENVIRONMENTAL IMPACT STATEMENT

Henderson, North Carolina
201 Wastewater Treatment System
Project No. C-370410

DRAFT (X)
FINAL ( )

Environmental Protection Agency
Region IV
345 Courtland Street
Atlanta, Georgia 30309
Mr. Bob Howard
404-526-5458

1. Type of Action: Administrative Action (X)
   Legislative Action ( )

2. Brief Description of Proposed Action:

This Environmental Impact Statement was prepared in response to the action of awarding grant funds to the City of Henderson, North Carolina for the purpose of developing a wastewater treatment system to service the Greater Henderson area. The project consists of the necessary facilities to process and treat approximately 3.7 million gallons per day (MGD) of wastewater. Vance, Warren, and Franklin Counties, North Carolina, will potentially be affected by the proposed action.

Three alternative systems were selected in the Draft EIS for final consideration:

Alternative A - Abandon the Red Bud Creek wastewater treatment plant; upgrade the existing Nutbush Creek wastewater treatment plant at a capacity of 1.58 MGD with odor controls and phosphorus removal; construct a 2.12 MGD wastewater treatment plant on Sandy Creek.

Alternative B - Abandon Nutbush Creek and Red Bud Creek wastewater treatment plants; construct a 3.7 MGD plant on Sandy Creek.

Alternative C - Abandon the Red Bud Creek wastewater treatment plant; upgrade and expand the Nutbush plant to 3.7 MGD, with phosphorus removal and odor controls.

A single system will be chosen for implementation after the public and agency review of this draft statement.

The proposed action will provide for:

(1) The removal of inadequately treated wastewater from the tributary streams.

(2) Wastewater treatment facilities to accommodate existing and future sources of wastewater.

(3) Alleviation of existing adverse conditions caused by low quality wastewater discharges.

(4) Allowance of orderly growth in the Greater Henderson area.

3. Summary of Major Environmental Impacts

The major environmental impacts with implementation of any of the three alternatives will be those associated with the water quality downstream of wastewater treatment plant discharges. Alternative A will cause moderate adverse impacts on Sandy Creek, a substantial improvement in water quality of Nutbush Creek, and a moderate increase in the water quality of Kerr Reservoir. Alternative B will cause a major improvement in the water quality of Nutbush Creek and a moderate adverse impact on Sandy Creek. Alternative C would cause a substantial increase in the water quality of Nutbush Creek and Kerr Reservoir.

Other notable impacts are caused primarily by short-term noise associated with construction activity, particularly for Alternatives B and C, increased erosion and sediment yield, particularly for Alternatives A and C, and the potential for affecting a National Historic site for Alternatives A and B.

4. Summary of Alternatives Considered

Initially, twenty separate alternatives were identified and evaluated. Of these, fifteen were selected and analyzed in detail on the basis of environmental impact and cost and are listed as follows:

(1) Three plants, one each on Nutbush, Red Bud, and Sandy Creeks

(2) Two plants, one each on Nutbush and Sandy Creeks

(3) Two plants, one each on Red Bud and Sandy Creeks

(4) One plant on Sandy Creek

(5) One plant on Kerr Reservoir

(6) Two plants, one each on Red Bud and Sandy Creeks with the Sandy Creek facility using land disposal

(7) Two plants, one each on Nutbush and Sandy Creeks with land disposal at the Sandy Creek facility (extended aeration)

(8) Two plants, one each on Nutbush and Sandy Creeks with land disposal at the Sandy Creek facility (aerated lagoon)

(9) Two plants, one each on Nutbush and Ruin Creeks

(10) One plant on Ruin Creek

(11) Two plants, one each on Nutbush and Red Bud Creeks with diffuser discharge from the Nutbush Creek facility into Kerr Reservoir

(12) Two plants, one each on Nutbush and Red Bud Creeks

(13) One plant on Nutbush Creek with diffuser discharge into Kerr Reservoir

(14) One plant on Nutbush Creek

(15) No action

5. Comments on the Draft Statement have been requested from the following:

Federal Agencies

Bureau of Outdoor Recreation
U. S. Coast Guard
Corps of Engineers
Council on Environmental Quality
Department of Commerce
Department of Health, Education and Welfare
Department of the Interior
Department of Transportation
Department of Housing and Urban Development

Economic Development Administration
Federal Highway Administration
Fisheries & Wildlife Service
Food and Drug Administration
Forest Service
Geological Survey
National Park Service
Soil Conservation Service
Federal Energy Administration
Federal Power Commission

Members of Congress

Honorable Robert Morgan	U. S. Senate
Honorable Jesse A. Helms	U. S. Senate
Honorable L. H. Fountain	U. S. House of Representatives

State

Honorable William E. Holshouser	Governor, State of North Carolina

Office of Intergovernmental Relations
North Carolina Department of Natural and Economic Resources
Council of Governments
Division of Archives and History
Commission of Agriculture
Office of State Planning
North Carolina Wildlife Resources Commission

Local

Mayor, City of Henderson
Chairman, Vance County Commissioners
City Manager, City of Henderson
Henderson-Vance County Planning Commission
Henderson-Vance County Chamber of Commerce
Mayor, City of Warrenton
Chairman, Board of Directors, Warrenton, N. C.
Mayor, City of Oxford
Mayor, City of Louisburg
Franklin County Commissioners
Warren County Commissioners

Interested Groups

Metrolina Environmental Concern Asso.
Keep North Carolina Beautiful, Inc.
Conservation Club
Trout Unlimited
North Carolina Forestry Asso.
North Carolina Lung Asso.
Duke Environmental Center
St. Andrews Public Interest Research
North Carolina Wildlife Federation

6. Date made available to CEQ and the Public

The Draft Statement was made available to the Council on Environmental Quality and the public during December, 1976.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IV
345 COURTLAND STREET
ATLANTA, GEORGIA 30308

December 6, 1976

TO ALL INTERESTED GOVERNMENT AGENCIES,
PUBLIC GROUPS, AND CITIZENS:

Today, the Environmental Protection Agency and the State of North Carolina, Department of Natural and Economic Resources, have made the draft environmental impact statement on the Henderson, North Carolina 201 Wastewater Treatment System, Project No. C-370410, available to the public and to the Council on Environmental Quality. Your copy is enclosed.

Copies of the impact statement are also available to the public for review at

Environmental Protection Agency
Region IV
345 Courtland Street, N. E.
Atlanta, Georgia

Department of Natural and
Economic Resources
417 North Salisbury Street
Raleigh, North Carolina

Leslie Perry Memorial Library
109 Young Street
Henderson, North Carolina

Franklin County Library
North Main Street
Louisburg, North Carolina

A Public Hearing will be held on this draft environmental impact statement Tuesday, January 18, 1977 at 7:00 p.m. at Henderson Junior High School, 219 Charles Street, Henderson, North Carolina. Registration will begin at 6:00 p.m. Persons wishing to speak will be called upon in order of registration.

Any comments you may have on this statement should be sent by January 21, 1977 to

John E. Hagan, III
Chief, EIS Branch
Environmental Protection Agency
1421 Peachtree Street, N. E.
Atlanta, Georgia 30309

John A. Little, Deputy
for Jack E. Ravan
Regional Administrator

SUMMARY

This Environmental Impact Statement was prepared jointly by the State of North Carolina Department of Natural and Economic Resources and the Environmental Protection Agency, Region IV, in response to legal requirements of the State of North Carolina and the United States. It addresses those areas stipulated by the National Environmental Policy Act of 1969, the North Carolina Environmental Policy Act of 1971, and the Council on Environmental Quality Guidelines of August, 1973.

1. Existing Environment

For the purposes of this Environmental Impact Statement (EIS) the study area is defined to include all of Vance County and adjacent portions of Warren and Franklin Counties. The total environment is divided into natural and man-made aspects and each, while interactive, are discussed separately. A map showing the designated 201 area and existing wastewater treatment facilities of Henderson, N.C. is presented in Figure 1. Supporting documentation is provided in a Technical Reference Document (RA-R-276).

a. Natural Environment

The study area enjoys a favorable climate, moderated by the comparative proximity of the Atlantic Ocean. Temperatures are moderate and rainfall is adequate. Winds normally are light and of a northerly or southerly direction for most of the year with occasional incursions of southwesterly winds as a result of the Bermuda high.

The ambient air quality in Henderson, Vance County, and surrounding counties is good. Levels of suspended particulates, sulfur dioxide, and nitrogen dioxide measured in recent years in Henderson are below the national ambient air quality standards and also have exhibited a downward trend.

On the basis of odor complaints registered with the City of Henderson, no widespread community odor problem presently exists. Sources of reported odor complaints are the Nutbush Creek treatment plant and a local industry. Reportedly, odor complaints have been diminishing from these acknowledged odor sources.

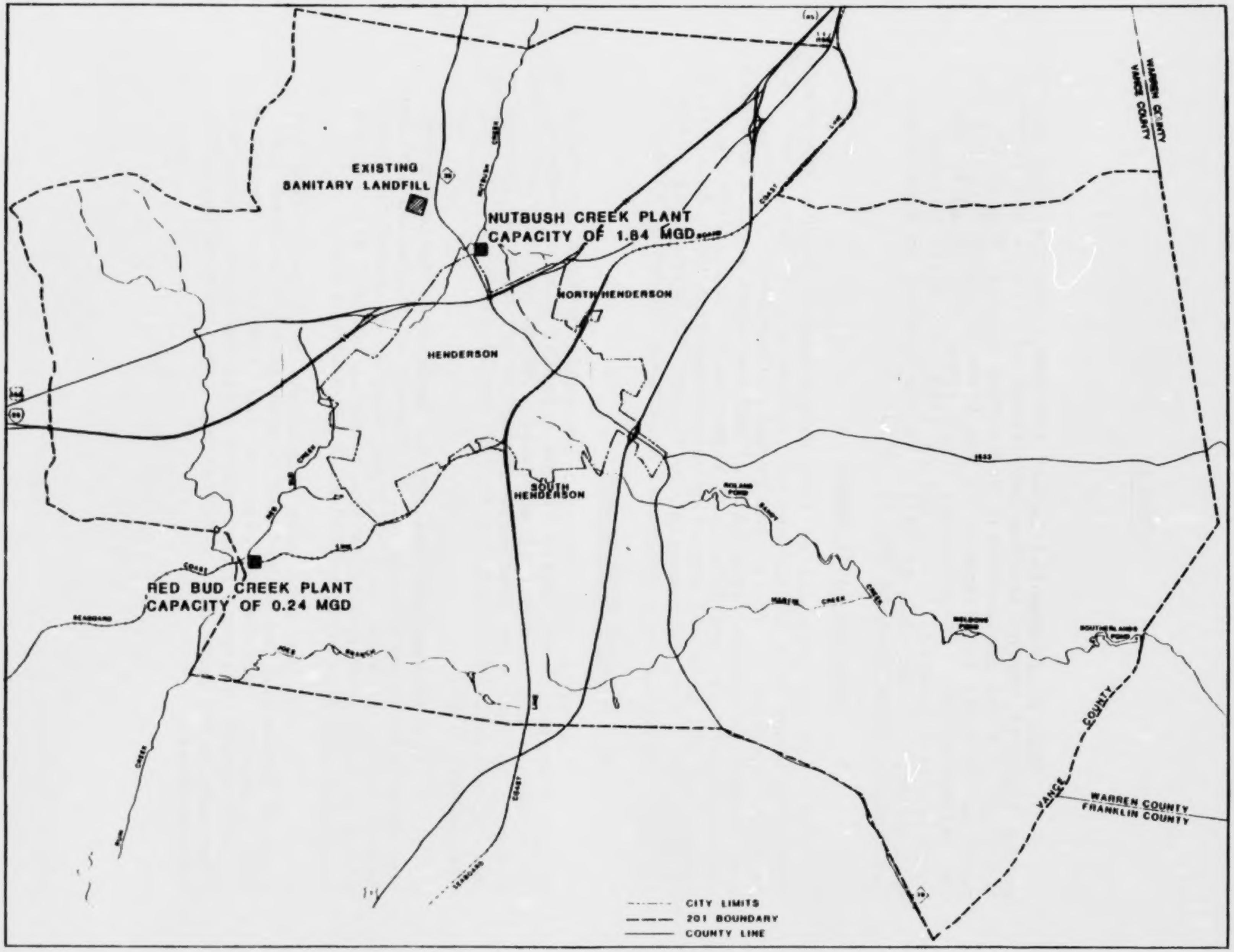

EXISTING
SANITARY LANDFILL
NUTBUSH CREEK PLANT
CAPACITY OF 1.84 MGD
NORTH HENDERSON
HENDERSON
SOUTH HENDERSON
RED BUD CREEK PLANT
CAPACITY OF 0.24 MGD
WARREN COUNTY
VANCE COUNTY
VANCE COUNTY
WARREN COUNTY
FRANKLIN COUNTY
CITY LIMITS
201 BOUNDARY
COUNTY LINE

FIGURE 1 EXISTING WASTEWATER TREATMENT SYSTEM AND 201 STUDY AREA

Henderson can be described as being neither very noisy nor very quiet, but rather typical of noise climates in similar cities throughout the nation. Rural and wilderness areas around Henderson also have noise character like that of similar areas in the nation.

The area is gently rolling Piedmont topography of low relief and is drained by small tributaries of the Tar River to the south and Roanoke River (John Kerr impoundment) to the north. The area is underlain by very old folded gneisses and schists and younger, discontinuous intrusions of chiefly granitic rocks. The structural grain is northeastward. Seismicity is low to moderate.

A variety of soil associations exist within the project area offering a wide range of suitability for various uses. Textures range from loamy sand to silty clay loam surface layers and sandy loam to clay subsoils. The depth of weathering is a key factor in determining the suitability of land uses, and most existing limitations are associated with thicker, more clayey residual materials.

Only small amounts of surface water exist in the area. Water is stored in John Kerr Reservoir, which impounds Nutbush Creek about 4 miles downstream from Henderson, and in a series of small lakes in upper Sandy Creek watershed. Henderson is drained by three creeks: Sandy Creek, with a 7-day, 10-year low flow of 2.3 cfs, Red Bud/Ruin Creeks, with low flows of 0.07 cfs, and Nutbush Creek, with a low flow of 0.04 cfs. The average flows of these streams are relatively equal.

Supplies of ground water are also restricted in both volume and yield. Two shallow aquifers exist, one in the residual saprolite that blankets nearly the entire area and another in the underlying, fractured bedrock. These aquifers are hydrologically connected to form an unconfined aquifer system. Overall, ground-water quality is very good for most uses and is widely used for domestic purposes.

Water quality of area streams is generally good, with the notable exception of Nutbush Creek which currently receives poorly-treated effluent from a pickle packing plant and an existing sewage treatment plant. Water quality of Kerr Reservoir is also good, despite very long detention times and very high nutrient loadings from Nutbush Creek that should promote eutrophy. Agricultural land runoff and septic tanks are probably the most important non-point sources of pollutants to both Kerr Reservoir and area streams.

Floodplains of streams in the area are narrow, although those of lower Tabbs and Ruin Creeks and, locally, Sandy Creek's are anomolously wide. Flooding is not perceived as a threat in the upper portions of these watersheds.

The shore of Kerr Reservoir, a variable level lake, may range in elevation from 268 feet above mean sea level (m.s.l.) to 326 feet m.s.l. Normal power pool elevation is 300 feet m.s.l. and the pool normally fluctuates by several feet above and below this elevation. The fluctuating water surface has produced a rather barren shoreline.

The vegetation of the areas to be affected by the Henderson wastewater treatment facilities consists primarily of river-edge hardwood and pine-hardwood forests. These intergrade as the elevation, soil types, and moisture content change with distance from the stream beds and as the altitude changes. The forests vary greatly in age and slightly in species composition depending upon how recently logging has taken place and whether the pines or the hardwoods were cut. The species composition of the wildlife of the area depends upon the type of vegetation, age, ground cover, and forest water availability. Nutbush Creek is not suitable habitat for most of its length downstream of the treatment facility for aquatic organisms. All other animals that require aquatic organisms for food are also missing from this section of Nutbush Creek. Red Bud, Sandy, and Martin Creeks are presently healthy, productive creeks with abundant aquatic and other related organisms. Fish are abundant in Martin and Sandy Creeks.

b. Man-Made Environment

The population of the study area has remained fairly stable for the past twenty years. The Vance County population has been between 32,000 and 33,000 since the 1950 census. The City of Henderson, however, has grown during this period from approximately 11,000 to 14,000. The racial composition of the area tends to be much more biracial than the rest of North Caroline with blacks comprising almost 45% of the population.

The median family income for the area is considerably lower than for the rest of the state. Due to many of the same conditions, the percentages of families below poverty level are higher than the state's percentages, with over 22% below poverty level in each of the three counties.

The population projections show very small increases for the area for the next 25 years.

The major economic sectors in the study area are manufacturing, agriculture, and wholesale and retail trade. In recent years, there has been a large increase in employment in manufacturing and a large decline in agricultural employment. Unemployment has been fairly high recently due to the loss in manufacturing jobs caused by national economic factors. The tax and debt data for the counties show small amounts of bonds outstanding and small per capita debts. The economic projections show that manufacturing should become the major economic sector by 1980. There should also be an increase in the labor force of the area.

About 64% of the total population of Vance County reside within an area of about 12 square miles which comprises Henderson township. About 14,000 people live in the City of Henderson. The study area has some forty industries, the principal ones being textile, chemical production, food, mineral, glass containers, mobile homes, garment manufacturing, and pulpwood production. Farming remains the predominant industry in Vance County, with tobacco as the major crop. Several programs focusing on land use planning are either underway or scheduled to begin in the near future, but no land use plan currently exists.

The North Carolina Inventory of Historical and Cultural Sites lists 18 sites within Vance County. Three of these sites have been included in the National Register of Historic Places. National Register sites in Warren and Franklin counties which fall within the impact area of the proposed project have also been inventoried. Because no archaeological survey has been performed in this area, a survey is being performed of the three alternatives sites selected for detailed investigation.

2. Alternatives

Some twenty different wastewater treatment facility alternatives were identified and examined as candidates for satisfying the wastewater treatment objectives. These alternatives were tested in a multilevel screening process involving environmental, engineering, legal, and cost constraints as well as citizen input. From this process, three alternative systems were chosen for detailed evaluation in this Draft EIS. From results of public and agency review, a single alternative will be selected for implementation. The paragraphs below summarize the three alternatives selected for further consideration.

Alternative A

Upgrade the existing Nutbush Creek wastewater treatment plant and maintain the capacity of 1.58 MGD; abandon the existing

Red Bud Creek wastewater treatment plant and pump the tributary wastewater from this basin to the Sandy Creek basin; construct a new 2.12 MGD wastewater treatment plant on Sandy Creek below Southerland's Pond; construct a pumping station at the confluence of Martin's Creek and Sandy Creek for pumping the Sandy Creek wastewater to the new facility below Southerland's Pond. This alternative is described graphically in Figure 2.

Alternative B

As presented in Figure 3, abandon both the Nutbush Creek and Red Bud Creek wastewater treatment plants; pump the tributary wastewaters from these basins to the Sandy Creek basin; construct a new 3.70 MGD wastewater treatment facility on Sandy Creek below Southerland's Pond; construct a pumping station at the confluence of Martin's Creek and Sandy Creek for pumping the Sandy Creek wastewater to the new facility below Southerland's Pond.

Alternative C

Upgrade the existing Nutbush Creek wastewater treatment plant and expand its capacity to 3.70 MGD and discharge to Nutbush Creek; abandon the Red Bud Creek wastewater treatment plant and pump its tributary wastewater to the Nutbush Creek basin. Refer to Figure 4 for a graphic description.

3. Environmental Effects

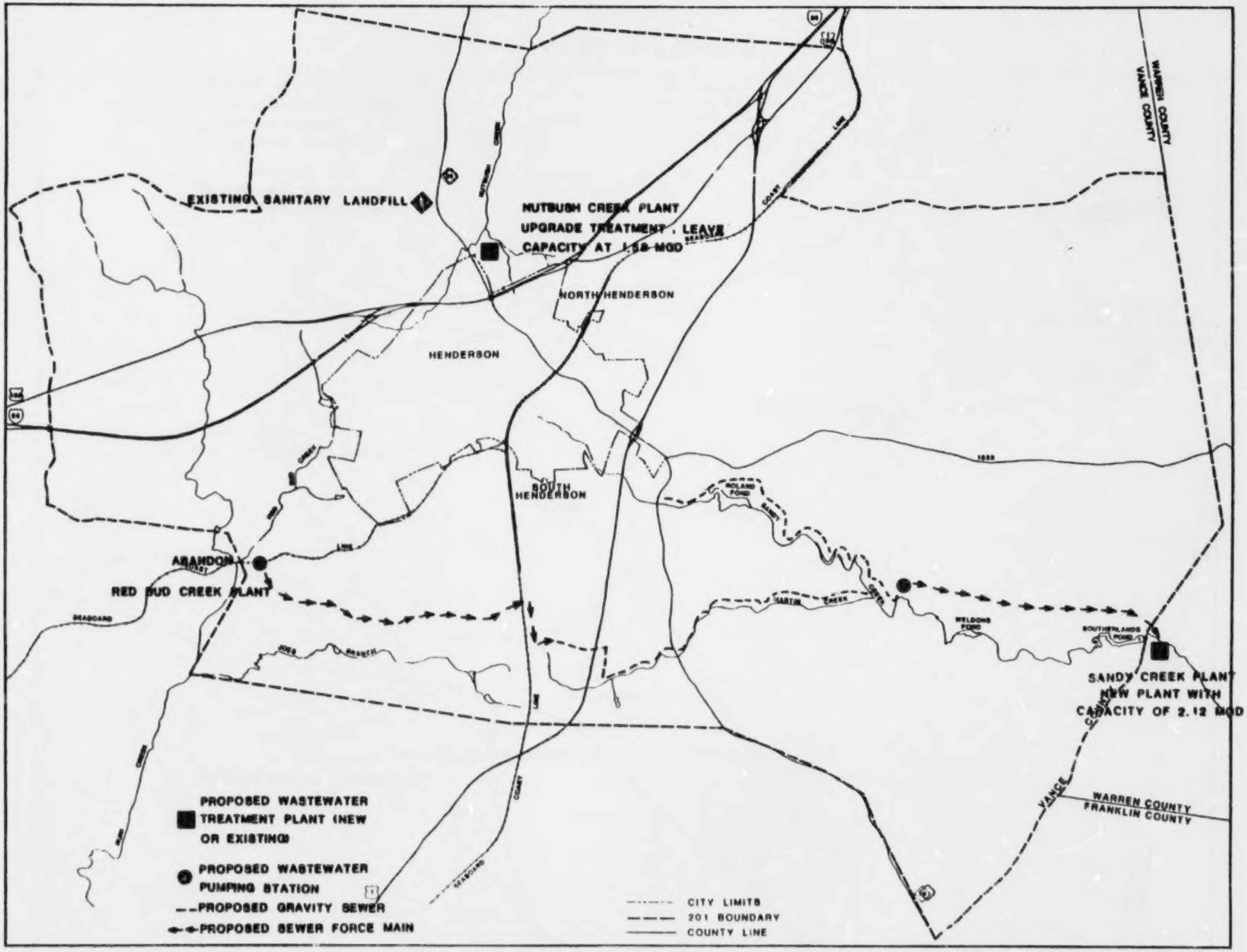
A synopsis of the major environmental effects is summarized below.

a. Natural Environment

Alternatives A, B, and C will have minor impacts on air quality. Construction activities for new waste treatment facilities will create a small amount of fugitive dust. The effects will be short-term and local. During operation of each system, air pollution effects will be negligible.

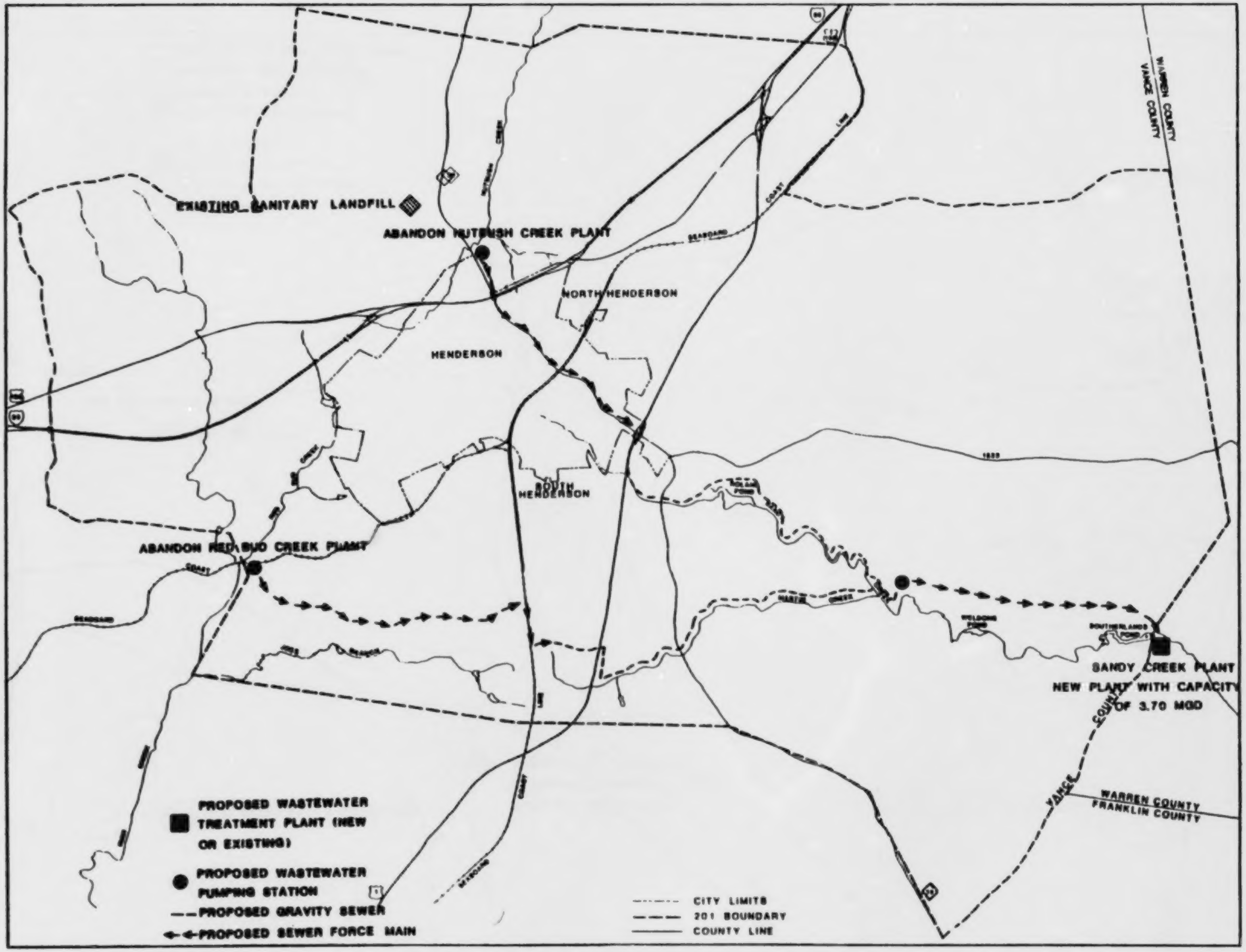
No significant negative odor impacts will occur during the normal operation of the waste treatment facilities in each of these systems due to the stringent odor controls to be installed. Minor odors emanating from the plants during extreme summertime conditions will not adversely affect the urban area of Henderson due to prevailing south to southwesterly winds.

Noise radiation from constructing sewer interceptors, force mains, and waste treatment plants will be of sufficient strength to cause interference of normal human outdoor activity during daytime hours at distances nominally of about 800 feet

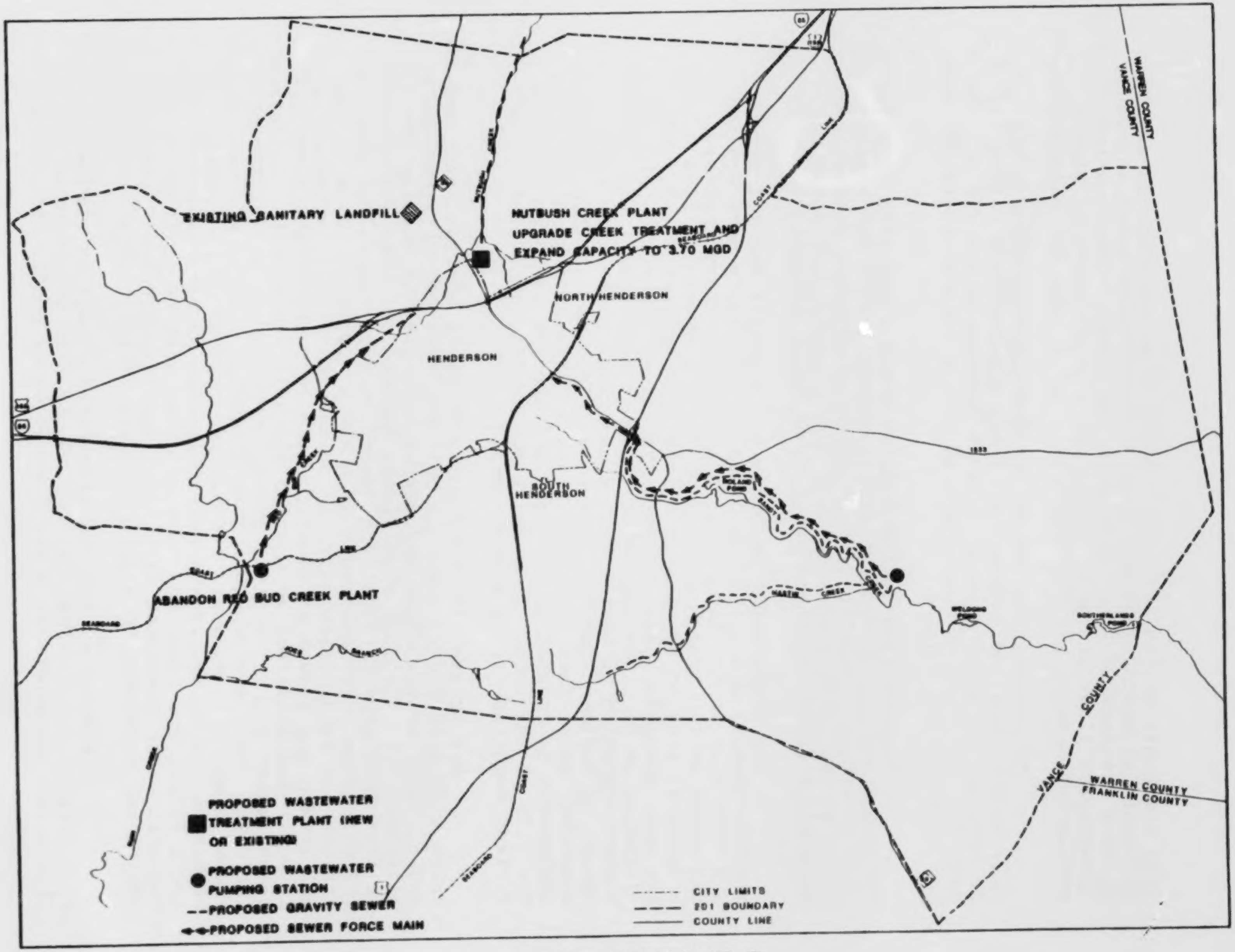

EXISTING SANITARY LANDFILL
NUTBUSH CREEK PLANT
UPGRADE TREATMENT, LEAVE
CAPACITY AT 1.58 MGD
NORTH HENDERSON
HENDERSON
SOUTH HENDERSON
ABANDON
RED BUD CREEK PLANT
ROLAND POND
SANDY
MARTIN CREEK
WELDONS POND
SOUTHERLANDS POND
SANDY CREEK PLANT
NEW PLANT WITH
CAPACITY OF 2.12 MGD
WARREN COUNTY
VANCE COUNTY
WARREN COUNTY
FRANKLIN COUNTY
VANCE
SEABOARD
COAST LINE
JONES BRANCH
PROPOSED WASTEWATER TREATMENT PLANT (NEW OR EXISTING)
PROPOSED WASTEWATER PUMPING STATION
PROPOSED GRAVITY SEWER
PROPOSED SEWER FORCE MAIN
CITY LIMITS
201 BOUNDARY
COUNTY LINE

ALTERNATIVE A

FIGURE 2


EXISTING SANITARY LANDFILL
ABANDON NUTBUSH CREEK PLANT
NORTH HENDERSON
HENDERSON
SOUTH HENDERSON
ABANDON RED BUD CREEK PLANT
SANDY CREEK PLANT
NEW PLANT WITH CAPACITY OF 3.70 MGD
WARREN COUNTY
VANCE COUNTY
VANCE COUNTY
WARREN COUNTY
FRANKLIN COUNTY
PROPOSED WASTEWATER TREATMENT PLANT (NEW OR EXISTING)
PROPOSED WASTEWATER PUMPING STATION
PROPOSED GRAVITY SEWER
PROPOSED SEWER FORCE MAIN
CITY LIMITS
201 BOUNDARY
COUNTY LINE

ALTERNATIVE B
FIGURE 3


WARREN COUNTY
VANCE COUNTY
EXISTING SANITARY LANDFILL
NUTBUSH CREEK PLANT
UPGRADE CREEK TREATMENT AND
EXPAND CAPACITY TO 3.70 MGD
NORTH HENDERSON
HENDERSON
SOUTH HENDERSON
ABANDON RED BUD CREEK PLANT
SEABOARD
COAST
LINE
VANCE COUNTY
WARREN COUNTY
FRANKLIN COUNTY
PROPOSED WASTEWATER TREATMENT PLANT (NEW OR EXISTING)
PROPOSED WASTEWATER PUMPING STATION
PROPOSED GRAVITY SEWER
PROPOSED SEWER FORCE MAIN
CITY LIMITS
201 BOUNDARY
COUNTY LINE

ALTERNATIVE C
FIGURE 4

from the construction activity. Noise from operation of aeration diffusers at waste treatment plants could create human annoyance up to a distance of 2,000 feet from the plant. Construction of interceptor lines and mains will pass through areas of higher population density for Alternatives A and B than for Alternative C.

No appreciable changes in drainage patterns in the area will result upon implementation of any alternatives. Blasting will be required to emplace sewer pipe at various points for all alternatives. Blasting will be required at the Nutbush Creek STP site for Alternatives A and C.

Construction at the Nutbush Creek plant site in Alternatives A and C will disturb easily erodible soil and erosion may lead to stream siltation without emplaced sediment control measures. Soils at the Sandy Creek site are less erodible and a natural vegetative buffer is anticipated to minimize siltation.

The increased flow below the outfalls for all three alternatives is not likely to cause significantly more erosion and siltation in the long term; a small, temporary increase may ensue as the stream adjusts to the new hydraulic load. This additional erosion appears more likely in Nutbush Creek, with its more erodible soils and with the larger wastewater discharge (Alternative C). The increased flows in Sandy Creek should not hamper operation of Laurel Mill downstream, although a small amount of sediment derived from sewer pipe installation in all alternatives or from increased flows in Alternatives A and B may ultimately be trapped at the pond and thereby slightly decrease the life of the pond. This decrement is not considered of sufficient magnitude to be significant.

Any stream siltation degrades water quality, and degradation will most likely occur in Nutbush Creek for Alternatives A and C; sewer construction may degrade the quality equally for all alternatives. The most significant impacts on water quality will be from discharge of treated effluent or from removal of poor quality discharge. For Alternatives A and B, nutrient loads in the effluent to Sandy Creek will, to an unknown degree, stimulate algal growth and growth of aquatic weeds in Sandy Creek, particularly in pools and ponds for an unknown distance downstream. In Nutbush Creek, water quality will be greatly improved by all alternatives, including those alternatives that discharge treated effluent to the creek (A and C). However, without the removal of phosphorus, Alternative C will hasten the eutrophication of Kerr Reservoir and could affect the taste and odor of water that is influent to the regional water treatment facility. This in turn would require additional treatment to alleviate these nuisance conditions.

Discharge of raw, unchlorinated sewage is highly unlikely at plants in any alternative; but should this very unusual condition occur, Alternatives A and B would cause public health hazards for several tens of miles downstream, including those portions of Sandy Creek used for water-contact recreation. That part of Kerr Reservoir used for water supply would not be endangered in either Alternative A or C in the event of system upset, but a slight hazard exists for water-contact recreation in a small area of the Nutbush Creek arm within the Class "C" portion.

Secondary or induced effects on the water regime relate principally to the increase in sewered and storm-sewered urbanized/suburbanized areas with all alternatives. Urban runoff will degrade existing water quality in the upper basins of all three watersheds draining Henderson, but especially Sandy and Red Bud Creeks. Urbanization will increase the discharge of peak flows and reduce the lag time of stream flow and storm events and also decrease or eliminate lower flows near the urbanized areas. The most important aspect of these changes is likely to be increased siltation with time, due to more erosion with progressively higher peak streamflows than would otherwise exist.

For Alternatives A and C, some increase in siltation and sedimentation in Kerr Reservoir at the mouth of Nutbush Creek will contribute to shoaling of the reservoir in that vicinity. Flood peaks and consequently the area flooded will increase with urbanization for all alternatives.

The biological effects of the three alternative systems are quite similar in most aspects. All will take between 75 and 100 acres of naturally-vegetated land out of its present production. Most of this land loss will be due to pipeline easements which will provide a different type of habitat such as grasses or low vines and shrubs. All alternatives will disturb the wildlife during construction; however, this should be short-term and readily minimized by mitigative measures. All three alternatives will discharge effluents into either Nutbush Creek, Sandy Creek, or both in varying amounts. Sandy Creek is presently in a highly productive natural state. Discharge of wastewater in Alternatives A and B may be expected to further increase the biotic productivity of this stream. Nutbush Creek is already highly disturbed by poor quality discharge. Upgrading the quality of the current discharge will have a positive effect on existing downstream conditions.

The construction of a wastewater treatment facility in Vance County will have a very small direct impact on the population of the county and the City of Henderson. The largest direct impact will be during the construction period. The long-term direct impact will be even smaller due to the small work force necessary. The indirect impact of the facility on the population could occur as a result of new industries locating in the area. This potentially large impact could bring about a resurgence in the declining population of the area.

The direct impact of the construction of a wastewater treatment facility on the economy of the region will be very small. A boost will be given to the economy by the construction wages and by the local purchase of items for construction. As is the case with the population, much larger impacts could result indirectly. The economy of Henderson and of the area would be greatly strengthened if new industry were persuaded to locate there.

No significant differences in effects on the population and economy are anticipated among the three alternatives.

Alternatives A and B will potentially affect Laurel Mill, a National Register site located approximately 11.1 miles downstream of the proposed Sandy Creek STP component. Noticeable impacts may be caused by the potential for water quality degradation and increased aquatic plant growth. Changes in streamflow will occur but are not considered to be an appreciable impact.

4. Mitigative Measures

Due to the adverse environmental impacts identified in the analysis summarized above, various mitigative measures are deemed to be necessary for implementing the alternatives under consideration. These measures include:

- Frequent watering of construction sites and unpaved access roads for fugitive dust control
- Installation of a chemical-type fume scrubber for the Nutbush Creek STP of Alternatives A and C
- Properly maintaining and efficiently muffling dozers, backhoes, and cranes, and reducing rock drill noise by acoustic mufflers and barriers
- Enclosure of motors, pumps, and control valves and acoustical lagging of valves and above-ground, high-pressure piping
- Implementation of erosion and sediment controls during construction such as avoiding disturbance of steep slopes, diversion of runoff away from construction sites, use of vegetative buffers and filters, and employing detention basins.

- Removal of phosphorus from wastewater by an additional unit process at the Nutbush Creek STP of Alternatives A and C
- Maintenance of forested strips around the Sandy Creek STP and staggering of sewer right-of-way
- Archaeological reconnaissance of exact sewer rights-of-way before excavation

5. Project Alternatives

After review by the public and various governmental agencies, one of the three alternatives will be selected as the most desirable on the basis of cost, overall adverse impacts, and overall beneficial impacts. A summary of major findings of the Draft EIS with respect to these alternative courses of action is presented as Table 1.

TABLE 1

SUMMARY OF COSTS AND MAJOR IMPACTS OF THREE ALTERNATIVE SYSTEMS[1]

SYSTEM	TOTAL TREATMENT COST[2]	PRESENT WORTH	MAJOR ADVERSE IMPACTS	MAJOR BENEFICIAL IMPACTS
A	$795/MG	$11,934,000	Erodible soil at Nutbush Creek site will cause increase in stream siltation during construction. Nutrients in Sandy Creek may cause increased algal growth. Laurel Mill, a National Register site, may be slightly affected by increased siltation and growth of nuisance aquatic plants from Sandy Creek STP discharge. Urbanization of area with time will degrade water quality of local streams.	Existing quality of Nutbush Creek will be greatly improved and the threat to Kerr Reservoir quality mitigated. System will permit industrial in-migration to 201 area and significantly improve the area's depressed economic conditions.
B	$832/MG	$12,455,000	Nutrients in Sandy Creek will cause increased algal growth. Laurel Mill, a National Register site, may be slightly affected by nuisance aquatic plant growth and increased siltation. Urbanization of area with time will degrade water quality of local streams. Construction of sewers through heavily populated areas will create adverse reaction to short-term noise.	Existing quality of Nutbush Creek will be greatly improved and the threat to Kerr Reservoir quality removed. System will permit industrial in-migration to 201 area and significantly improve the area's depressed economic conditions.
C	$703/MG	$10,587,000	Erodible soil at Nutbush Creek STP will cause increase in stream siltation during construction. Urbanization of area with time will degrade water quality of local streams. Construction of sewers through heavily populated areas will create adverse reaction to short-term noise.	Existing quality of Nutbush Creek will be greatly improved and the threat to Kerr Reservoir quality mitigated. System will permit industrial in-migration to 201 area and significantly improve the area's depressed economic conditions.

[1] With Mitigating Measures

[2] Dollars per million gallons of wastewater treated at design capacity

I. INTRODUCTION

A. Legislative

All agencies of the Federal government and the State of North Carolina are required by law* to prepare a detailed environmental impact statement (EIS) for legislative and all other major actions significantly affecting the quality of human environment. The objectives of implementing the EIS process are to (1) build into the decision-making process an appropriate and careful consideration of all environmental aspects of proposed actions, (2) explain potential environmental effects of proposed actions and their alternatives for public understanding, (3) avoid or minimize adverse effects of proposed actions, and (4) restore or enhance the quality of the environment as much as possible.

The North Carolina Department of Natural and Economic Resources in concert with the Environmental Protection Agency determined that the issuance of federal and state funds for Henderson, North Carolina Wastewater Treatment Facility constitutes a major action significantly affecting the quality of the human environment. Consequently, decisions were made to prepare a joint federal-state EIS, the Notice of Intent for which was released on June 26, 1975.

B. Historical

Henderson, North Carolina, is situated at the headwaters of tributaries to the Tar and Roanoke Rivers, and transient

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*National Environmental Policy Act of 1969 (NEPA), 16 U.S.C. 4321 *et seq*., as implemented by Executive order 11514 of March 5, 1970, the Council on Environmental Quality (CEQ) Guidelines of August 1, 1973; North Carolina Environmental Policy Act of 1971 (1971 C. 1203, S.1), N. C. Gen. Stat. Ch: 113A (Cum. Supp. 1973).

surface water is not abundant. Water storage facilities, notably John Kerr Reservoir north of Henderson but also including numerous smaller ponds and reservoirs, are used to assure adequate water supplies for municipal, industrial, and agricultural uses. A very restricted ground-water resource is available in most places for domestic supplies.

Since the creeks of the area have relatively small flows, they are particularly subject to degradation by point and non-point sources of pollutants. Nutbush Creek, tributary to Kerr Reservoir, is grossly polluted, due primarily to poor quality municipal wastewater. The municipal wastewater facilities receive substantial contributions of industrial wastewater of varying characteristics, which are partly responsible for the poor effluent quality. Urban runoff from the Henderson vicinity undoubtedly adversely affects in-stream quality in the upper portions of the watersheds, and in the lower portions agricultural runoff has a small but generally discernible effect on stream quality.

The City of Henderson, North Carolina, is, therefore, applying for federal EPA and state funds to provide expansion and improvement of the city's wastewater treatment facilities. The primary objectives of this proposed action are (1) to provide wastewater treatment facilities for the City of Henderson, (2) to achieve the current and future state and federal water quality goals, and (3) to accommodate both domestic and industrial growth.

After consideration of twenty proposed wastewater treatment facility alternatives for providing facilities for the attainment of the project objectives, three were selected for public review and comment in this Draft Environmental Impact Statement. Alternative A recommends a two-plant configuration, upgrading the existing 1.84 MGD Nutbush Creek plant for treatment and discharge to Nutbush Creek, and constructing a new 2.12 MGD plant on Sandy Creek below Southerland's Pond for treatment and discharge to Sandy Creek. Alternative B recommends a single new 3.70 MGD wastewater treatment plant on Sandy Creek below Southerland's Pond for treatment and discharge to Sandy Creek. Alternative C recommends a single 3.70 MGD wastewater treatment plant on Nutbush Creek. The existing 1.84 MGD Nutbush Creek plant would be upgraded and expanded to the new design capacity and effluent would be discharged to Nutbush Creek. The general locations of interceptors, collectors, pumping stations, force mains, treatment facilities, effluent disposal, and sludge disposal sites for each of the three remaining facilities are presented in Figures 2 through 4 of the Summary.

The complete construction of any of the alternatives described will occur over a 15 to 18 month period. Initial construction should begin early in 1977.

A chronological presentation of the project history and the events leading to the proposed action is provided below.

February, 1972	- L. E. Wooten and Company submitted report on wastewater Treatment Improvements for the City of Henderson, North Carolina, to the Office of Water and Air Resources of the State of North Carolina Division of Natural and Economic Resources (DNER). This report contained a study of one alternative which was a 3-plant configuration. After review, the State of North Carolina DNER requested that L.E. Wooten perform additional studies on additional alternatives.
October 18, 1972	- Federal Water Pollution Control Act Amendments, PL 92-500, enacted by Congress.
November, 1972	- L.E. Wooten submitted revised report which included an investigation of four alternatives to the DNER.
February 28, 1973	- City of Henderson, North Carolina, filed state and federal grant applications for wastewater treatment plant improvements.

March 5, 1973 - State of North Carolina approved preliminary engineering report.

June 2, 1973 - City of Henderson, North Carolina, passed $1 million bond issue for wastewater treatment improvements.

July 10, 1973 - Preliminary engineering report amended to include Infiltration/Inflow analysis as required by the Federal Water Pollution Control Act Amendments of 1972 (FWPCA), PL 92-500.

January 16, 1974 - Engineering report revised to include guidelines as specified in Section 201 of FWPCA and became Facilities Plan.

March 22, 1974 - Facilities Plan submitted to the City of Henderson for review.

March 25, 1974 - City of Henderson, North Carolina, purchased option on land below Southerland's Pond owned by A. C. Coghill.

April 10, 1974 - Facilities Plan presented to local citizens at a public hearing.

May 30, 1974 - Facilities Plan submitted to the State of North Carolina, DNER, and the U.S. Environmental Protection Agency for review.

June 10, 1974 - City of Henderson filed state and federal grant applications for Step 1 and Step 2 funding.

August 1, 1974 - Grant application filed on February 28, 1973 returned.

August 8, 1974 - Amendment #1, which answers state and EPA reviews' questions submitted for addition to Facilities Plan.

November 7, 1974 - State of North Carolina, DNER requested that three additional alternatives be investigated and included in Facilities Plan.

December 20, 1974 - Amendment #2 submitted for addition to the Facilities Plan to include investigation of 3 additional alternatives.

February 17, 1975 - State of North Carolina DNER requested an Environmental Impact Statement.

June 6, 1975 - EPA requested that additional items be included in the Facilities Plan and that the Facilities Plan be restructured.

June 26, 1975 - EPA and North Carolina Department of Natural and Economic Resources issued Notice of Intent to prepare an Environmental Impact Statement.

December, 1975 - Radian Corporation of Austin, Texas, initiated studies to generate an Environmental Impact Statement under the direction of the U.S. EPA and the State of North Carolina DNER.

January, 1976 - L.E. Wooten submitted final Facilities Plan to State of North Carolina and U. S. Environmental Protection Agency.

January, 1976 - Radian Corporation introduced to local citizens group and presented alternatives to be investigated and methodology to be used for development of Environmental Impact Statement.

March 31, 1976 - Citizens' advisory committee ranked importance of environmental parameters.

April 26, 1976 - Radian Corporation presented to U.S. EPA environmental and cost rankings of 15 alternatives for selection of proposed action.

April 28, 1976 - Radian Corporation presented to State of North Carolina DNER environmental and cost rankings of 15 alternatives for selection of proposed action.

April 30, 1976 - U.S. EPA and State of North Carolina DNER decided to investigate three alternatives in detail in an Environmental Impact Statement.

May, 1976 - Radian Corporation initiated detailed study of three selected alternatives.

June, 1976 - Radian Corporation distributed a preliminary draft to cognizant parties for review and comment.

The total project costs, including costs for treatment plants; major interceptors and collectors; pumping stations; force mains; engineering, legal, and contingency services; and additional land are summarized below for each of the three alternatives. Costs for certain appurtenances such as land which are not eligible for federal or state funding are also included.

Alternative	Total Project Cost	Total Costs Ineligible For Federal or State Funding
A	$7,049,000	$180,000
B	$9,076,000	$220,000
C	$6,291,000	$170,000

Upon approval of the grant application, the federal government will finance 75% of the total eligible project cost. The State of North Carolina has a grant program to assist in the construction of wastewater treatment facilities by local governments. The funds for this grant program are allocated from monies made available by the N.C. Clean Water Bond Act of 1971. Currently, funds available for this program are not sufficient to support the State supplemental grant program through July 1, 1977, due to the large number of wastewater treatment projects which will be eligible for consideration during the grant period ending December 31, 1976.

Since the State of North Carolina is not able to commit funds on wastewater facilities projects until final plans and specifications for such projects are submitted and approved by the N.C. Department of Natural and Economic Resources, the ability of the State of North Carolina to finance an additional 12.5 percent of the total eligible project costs is unknown at this time and will be contingent upon the availability of funds at that time when plans and specifications for facilities are approved. If state funds are available, the remaining 12.5 percent will be locally funded. If state funds are not available, the local entities will be required to finance 25% of the total eligible project costs. The federal, state, and local shares of the total project costs for each of three alternatives are presented below.

State funds available:

ALTERNATIVE	FEDERAL	STATE	LOCAL	TOTAL
A	$5,150,750	$ 858,625	$1,038,625	$7,049,000
B	6,642,000	1,107,000	1,327,000	9,076,000
C	4,590,750	765,125	935,125	6,291 000

State funds not available:

ALTERNATIVE	FEDERAL	LOCAL	TOTAL
A	$5,151,750	$1,897,250	$7,049,000
B	6,642,000	2,434,000	9,076,000
C	4,590,750	1,700,250	6,291,000

II. EXISTING ENVIRONMENT

The total environment is a dynamic and interlocking system which may be broken arbitrarily into logical divisions for examination and analysis. It must be borne in mind, however, that the division being investigated is not functionally separated from the total environment.

The existing environment of the study area is divided into the natural environment and the man-made environment. The natural environment may be regarded as those things which are external to, but which influence and are influenced by, man's social structures. Conversely, the man-made environment may be regarded as those things present in the environment which are the products of man and his social structures, for example, demography, economics, and economic geography.

A. Natural Environment

For the purpose of describing the natural environment, the study area will consider all of Vance County and adjoining portions of Franklin and Warren Counties. The natural environment has been defined as the area of the total environment external to man and his social organization. For convenience of description, the natural environment will be separated into physical and biological components. Supporting material will be found in the Technical Reference Document (RA-R-276).

1. Physical Components

The physical components of the natural environment to be considered are the atmosphere, the land, the water, and the land/water interface. Additionally, sensitive physical components of the natural environment are identified.

a. Atmosphere

The following paragraphs summarize data descriptive of the atmospheric conditions present in the study area. Data on climatic conditions are given, as are atmospheric parameters indicative of general quality.

(1) Climate

Henderson is located in the northern Piedmont area of North Carolina. The area around Henderson is gently rolling and contains no significant topographical feature that would have any consequence on synoptic scale (macroscale) weather systems; however, microscale effects on the weather are possible. Low-level transport winds may be significantly reduced within areas densely covered by trees. Moreover, the frequency and duration of dense fog may be significantly increased in the immediate vicinity of Kerr Reservoir due to the available surface moisture in the environs of the reservoir.

The study area enjoys a favorable climate throughout the year due to its southern latitude and due to the moderating effect of the Atlantic Ocean. Average annual temperatures are around 60°F, with the coolest month being January and the warmest being July. Summertime temperatures are not extreme, and temperatures of 90°F or above were reported on 48 days. Wintertime temperatures are also not extreme with 75 days having temperatures of 32°F or below. The time from the first day with a temperature of 32°F or below to the last day is 193 days.

Annually, snow or rain occurs typically on 113 days. Snowfall amounts vary significantly on a year-to-year basis, but normally the study area receives 7.4 inches of snow per year.

Annual rainfall in the region has ranged from 34 to 64 inches, but an average 45.5 inches of rain falls per year. The majority of this rain is received in July; October is the driest month. A 100-year mean recurrence for 30-minute rainfalls of 3 inches has been established, and the mean recurrence of 24-hour rainfalls of 7.9 inches is also 100 years.

In the study area, the mean relative humidity is 71% during the year. The driest month is February, and August is the most humid. Humidities vary with time of day, generally being least humid when temperatures are lowest.

Dense fog occurrences are frequent in the northern Piedmont area. Heavy fog incidences (those fogging conditions which reduce the visibility to one-quarter mile or less) occur approximately 36 times during the year, usually during the early morning hours. Strong insolation during the late morning hours typically disperses heavy fog conditions; however, the duration of the heavy fog conditions may be extended during certain synoptic situations such as imminent cold and warm frontal passages and also during the continuous advection of warm, moist air over a cooler surface.

The strongest winds are reported in March and are attributable to the available energy derived from thermal atmospheric contrasts as the atmosphere changes from a winter to a summer regime. Weakest winds occur in October and are caused by weak pressure gradients. Wind speeds in the Piedmont Region vary only sightly throughout the year and average 8.0 mph. A high incidence of northerly and southerly winds occurs due to the frequent passage of extratropical cyclones. Seasonally, southerly winds are common in the summer months, although they show a strong persistence throughout the year. Northerly winds, conversely, occur with maximum frequency in the winter. A secondary maximum wind flow from the southwest results from the semi-permanent Bermuda high pressure system. Wind roses are presented in Figures II-1 and II-2.

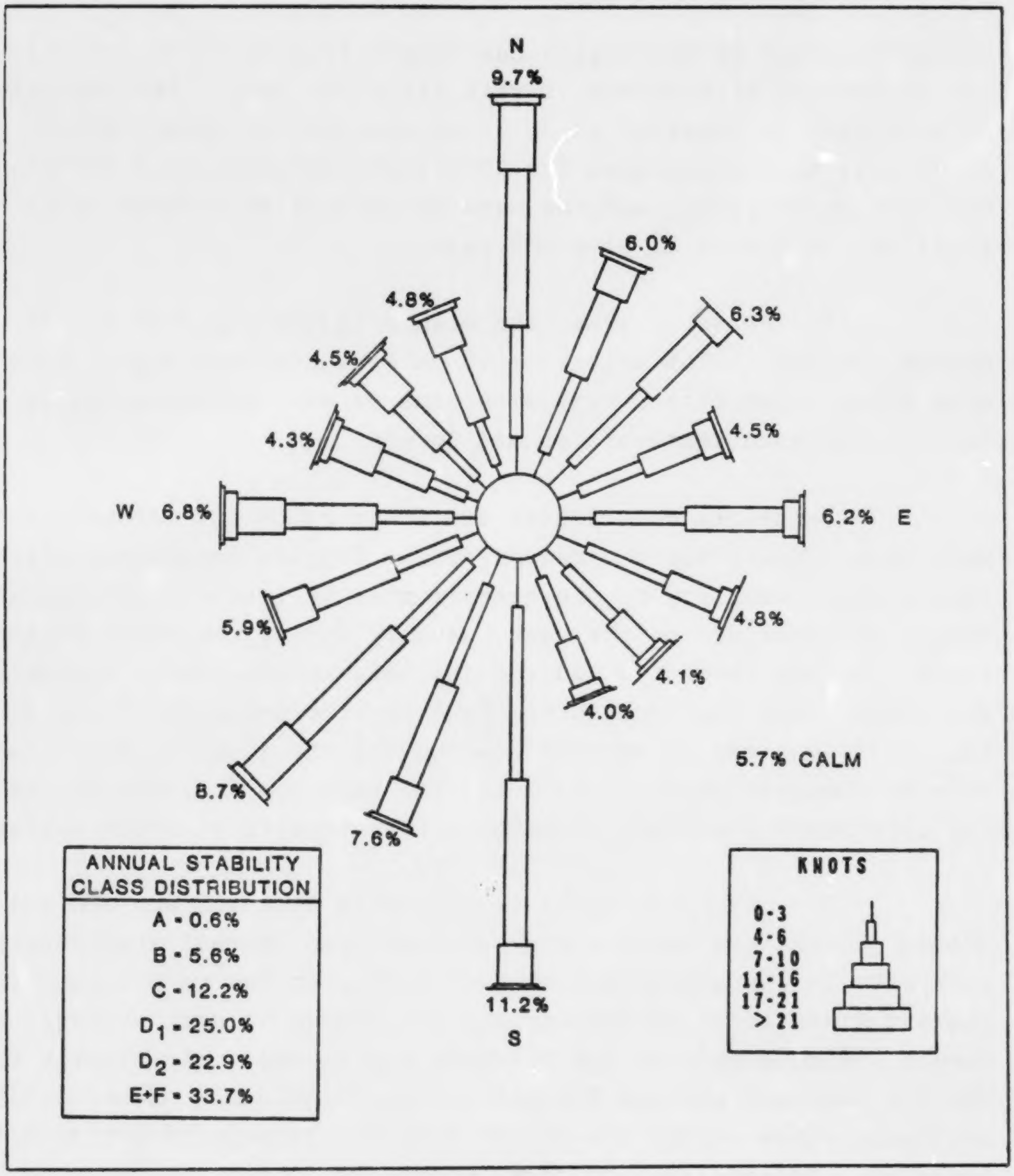

FIGURE II-1

ANNUAL WIND ROSE
RALEIGH, NORTH CAROLINA
COVERS PERIOD 1969-1974

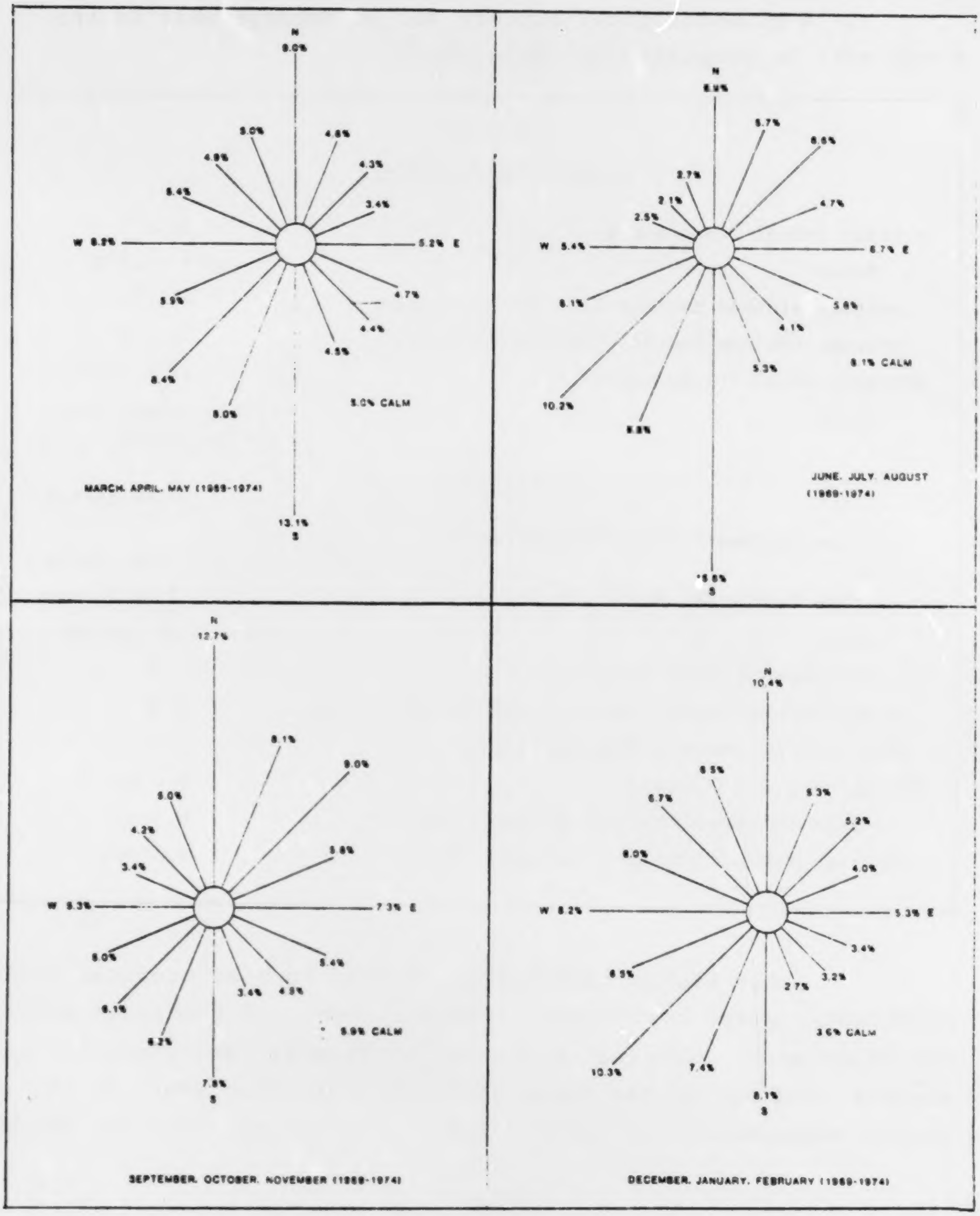

FIGURE II-2

SEASONAL WIND ROSES
RALEIGH, NORTH CAROLINA

A climatological summary for an average year in the study area is presented in Table II-1.

TABLE II-1

Climatological Summary

Average Annual Temperature	59.8°F
Range	(50°F - 70°F)
Average Minimum Monthly Temperature (January)	41.7°F
Average Maximum Monthly Temperature (July)	78.4°F
Average Annual Precipitation	45.5 inches
Range	(34 in. 1940, 1965; 64 in. 1936)
Average Minimum Monthly Precipitation (October)	2.68 inches
Average Maximum Monthly Precipitation (July)	5.95 inches
Average Yearly Snowfall	7.40 inches
Range	(trace - 25 inches)
Average Mean Relative Humidity	71%
Mean Minimum Monthly Humidity (February)	60%
Mean Maximum Monthly Humidity (August)	82%
Average Annual Windspeed	8.0 mph
Average Minimum Monthly Windspeed (October)	6.5 mph
Average Maximum Monthly Windspeed (March)	9.6 mph

Catastrophic meteorologic events such as tropical cyclones hurricanes, great hurricanes, thunderstorms, and tornadoes affect the study area. Tropical cyclones, hurricanes, and great hurricanes achieve landfall on the North Carolina coast once every 8, 10, and 35 years, respectively (SI-110). Due to its inland location, Henderson is protected from damage by storm surge and from many of the effects of the high winds but is affected most heavily by the heavy rainfalls incurred by these tropical activities. "Extreme mile" winds, the strongest sustained one-minute windspeeds expected to occur in a region within a certain recurrence interval at a standard height of 30 feet above the ground, will generally be caused by hurricanes, tropical storms, and, rarely, extratropical cyclones. For Vance County, "extreme mile" winds of 80 mph have a mean recurrence interval of 50 years, and winds of 100 mph have a mean recurrence of 100 years in the northern Piedmont Region (TH-079).

"Extreme mile" winds also occur with localized severe thunderstorms. Those thunderstorms which occur in the northern Piedmont Region are, however, not generally severe, with only 2% severe enough to cause hailstones on the ground. Thunderstorms occur at a frequency of 46 days per year. The number of tornado occurrences in North Carolina is small due to the lack of severity of most thunderstorms.

(2) Atmospheric Parameters

The North Carolina area has a moderate problem with large scale poor dispersion. The problem arises from the tendency towards upper-level ridging aloft accompanied by high pressure systems in the lower atmosphere in the eastern United States.

Considering the Pasquill atmospheric stability classification technique on an annual basis, the stability distribution is skewed toward the neutral (D_1, D_2) and stable E, F) classes. The cause of the higher incidence of E and F stability classes is the high frequency of low level atmospheric inversions in the northern Piedmont Region (34% compared to the national range of 5-45%). These inversions tend to stabilize the lowest levels of the atmospheric mixing layer and retain atmospheric pollutants at lower elevations rather than dispersing them throughout the atmosphere.

The 34% annual frequency value mentioned above applies to the cumulative frequency of inversions, i.e., it takes into account the weak as well as the strong inversions. During a five-year study period conducted by Holzworth (HO-049), a total number of 20 days occurred in the northern Piedmont Region during which a high meteorological potential for air pollution existed. This implies that a 1% annual frequency of occurrence of severe air pollution conditions (or severe inversion conditions) occurs in the Henderson area.

Air Quality

The study area is in the Eastern Piedmont Air Quality Control Region (AQCR). In 1972 this AQCR was assigned air pollutant priorities under the state implementation plan to achieve the National Ambient Air Quality Standards (NAAQS). These priorities were based on existing air quality where known, or estimates if not known. The AQCR was designated priority I for suspended particulates, priority III for sulfur dioxide (SO_2), priority III for nitrogen dioxide (NO_2), priority III for carbon monoxide (CO), and priority III for oxidants (hydrocarbons). Priority I designated regions had pollutant concentrations generally higher than the primary air quality standards level; priority III regions had pollutant concentrations generally lower than secondary air quality standards levels. Secondary standards are generally more stringent than primary standards.

While the data available for Henderson indicate that the suspended particulate levels are and have been substantially lower than below the secondary standards level since 1972, the Eastern Piedmont AQCR still carries a priority I classification for suspended particulates. This may be accounted for by other emissions sources* outside the study area but still within the AQCR. Table II-2 summarizes measured values of ambient air pollutant concentrations for Henderson, North Carolina, and contrasts them with priority III levels.

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*Defined as any source which, if uncontrolled, would emit more than 100 tons per year of any criteria pollutant.

TABLE II-2

Ambient Air Pollutant Concentrations For Henderson, North Carolina ($\mu g/m^3$)

	1972	1973	1974	1975	Priority III Levels
Particulates	49	41	34	36	<60[1]
Sulfur Dioxide	18	12	8	7	<60[2]
Nitrogen Dioxide	32	19	15	15	<110[2]

[1] Annual Geometric Mean
[2] Annual Arithmetic Mean

Emission point sources within Vance County are few. As of January 6, 1976, six point sources were designated by the North Carolina Department of Natural and Economic Resources, Air Quality Section. These sources are Laurens Glass, Vulcan Materials, S. T. Wooten Construction, Perry Lumber, J. P. Taylor, and Burkhart-Carolina. Laurens Glass is currently on a compliance schedule to upgrade some control equipment at their plant, and Burkhart-Carolina is constructing a new plant to be completed by the end of the year which will conform to all air pollution regulations. No other sources in the county are on schedules.

Current quantitative air pollution emission levels for the county are not available, but the good ambient air quality can be construed to reflect relatively low emission levels. In the near future no additional major sources of air pollution are expected for the county. On that basis, the existing trends of good ambient air quality can be expected to continue.

Odor

At the state level, no industries are affected by the State's Regulation No. 5, Control and Prohibition of Odorous Emissions (RA-273). A subjective method of odor detection in ambient air by community perception (CH-196) was employed to characterize odors in the Henderson study area.

Two community-perceived sources of odor have been identified, the municipal waste treatment plant at Nutbush Creek and the Perfect Packed Pickle Company. Formerly, Perfect Packed liquid wastes were treated at the Nutbush Creek wastewater facility. At present, the company's wastes are treated on-site in aerated lagoons. Since the company commenced on-site treatment, community odor complaints regarding both the Nutbush Creek wastewater facility and the Perfect Packed Pickle Company have decreased. No seasonal variations in number of complaints regarding either odor source were noted (RA-274).

Noise

To describe the relationship of noise to the human environment, an accepted measure of noise must be chosen. More than twenty different measures have been devised to describe noise events. Of these, the Environmental Protection Agency recommends the use of the day-night sound level, L_{dn}*, as the preferred descriptor for evaluating the interference of noise with human activities (EN-103).

Extensive studies correlating general noise level with population density have been performed under the sponsorship of the EPA (GA-171). Results of these studies revealed that a reasonable estimate of L_{dn} in the study area could be computed from the relationship*

---

*Technically, the day-night sound level is the equivalent A-weighted sound level (dBA) over a 24-hour period, with average sound levels between 11:00 PM and 7:00 AM increased by 10 decibels.

$$L_{dn} = 10 \log N + 22 \text{ dB}$$

where L_{dn} is the day-night sound level, and N is the population density in thousands of people per square mile.

For Henderson and Henderson Township, population density generally ranges from about 1800 to 2500 people per square mile. Applying this range to the equation yields a typical urban and residential range of about 57-62 dB. Spot sound level measurements made on the fringes of Henderson and at locations in downtown areas revealed levels as low as 50 dBA** and as high as 62 dBA which lend credence to the mathematical prediction.

Within urban and residential Henderson, the most obvious and predominant source of noise observed during the noise measurement exercises was that of moving vehicles. Near traffic, it was common to observe levels as high as 65 to 70 dBA in both daytime and nighttime hours. These levels were more prevalent during 7-9AM and 4-6PM, reflecting "rush-hour" conditions. At nighttime, barking of dogs, motorcycles and vehicular traffic accounted for the principal noise increases in residential areas.

Noise levels in the non-populated areas around Henderson will vary considerably but are generally found to be between 40 and 50 dBA. Sound level measurements in wooded areas near Kerr Lake ranged as low as 35 dBA during still conditions and as high as 50 dBA when wind speeds were from five to eight miles per hour.

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*This relationship is applicable for locations away from major traffic arteries and airports.

**dBA refers to a single value measure read from the sound level meter to be used in the computation of L_{dn}.

In rural and undeveloped areas, the primary noise source was that of vegetation interaction with wind. The observations were made during periods that were cold for the region and, consequently, other typical sources such as sounds from birds, animals, and livestock were not noticed. During more temperate weather, these influences will affect the overall noise conditions but not appreciably on a large scale basis. As with other areas, passing vehicles and flying aircraft temporarily increased noise levels. Also, along the shores of Kerr Lake, noise from motored pleasure boats will cause a significant increase in noise level during the outdoor recreational season.

In summary, noise in rural and undeveloped areas around Henderson can be typified with an L_{dn} ranging from about 40 to 45 dB. These values are probably the most representative of any 5 dB range for any period of the day and any time of the year.

b. Land

The study area as defined lies entirely within the Piedmont Province. The topography (Figure II-3) is comprised of gently to moderately rolling hills. The uplands generally show a subdued northeast trend, and while the overall relief is about 300 feet, local relief is rarely more than 75 feet.

The area is drained by numerous small creeks with a major drainage divide extending roughly east-west across the region (see Figure II-3). To the north, streams such as Nutbush Creek and Island Creek are tributary to the Roanoke River, and to the south, streams such as Sandy Creek and Ruin/Tabbs Creeks are tributary to the Tar River. Most of the study area is in the Tar River Basin, although the Tar River-Sandy Creek confluence is far from the study area. The remainder of the study area is in the Roanoke River Basin. The Roanoke River is impounded to the north of the study area by the John H. Kerr Dam,

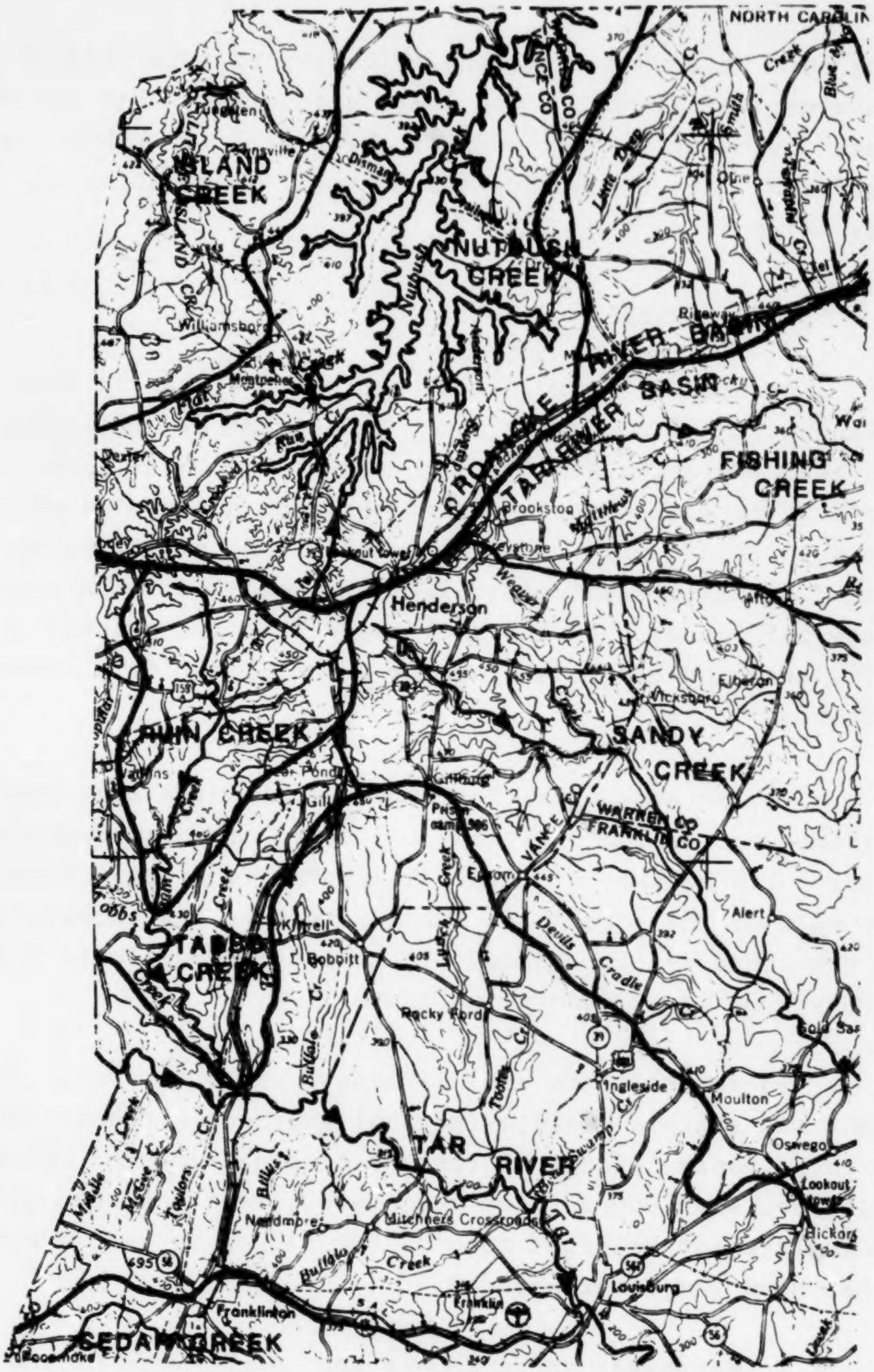

NORTH CAROLIN
ISLAND CREEK
NUTBUSH CREEK
ROANOKE RIVER BASIN
TAR RIVER BASIN
FISHING CREEK
Henderson
Williamsboro
Montpelier
Dexter
Brookston
Kittrell
Bobbitt
Rocky Ford
Epsom
Vicksboro
Elberon
Alert
Ingleside
Moulton
Oswego
Lookout Tower
Nelsonia
Mitchners Crossroads
Franklinton
Louisburg
Gillburg
RUIN CREEK
SANDY CREEK
WARREN CO
FRANKLIN CO
VANCE CO
TABBS CREEK
TAR RIVER
CEDAR CREEK
Pocomoke

FIGURE II-3
GENERAL TOPOGRAPHY AND APPROXIMATE DRAINAGE BASIN BOUNDARIES

forming Kerr Reservoir. A large tributary of this reservoir is the embayment of Nutbush Creek. It is important that the major drainage divide of the Tar and Roanoke Rivers is within the City of Henderson; only the headwaters of small tributaries are immediately adjacent to the city.

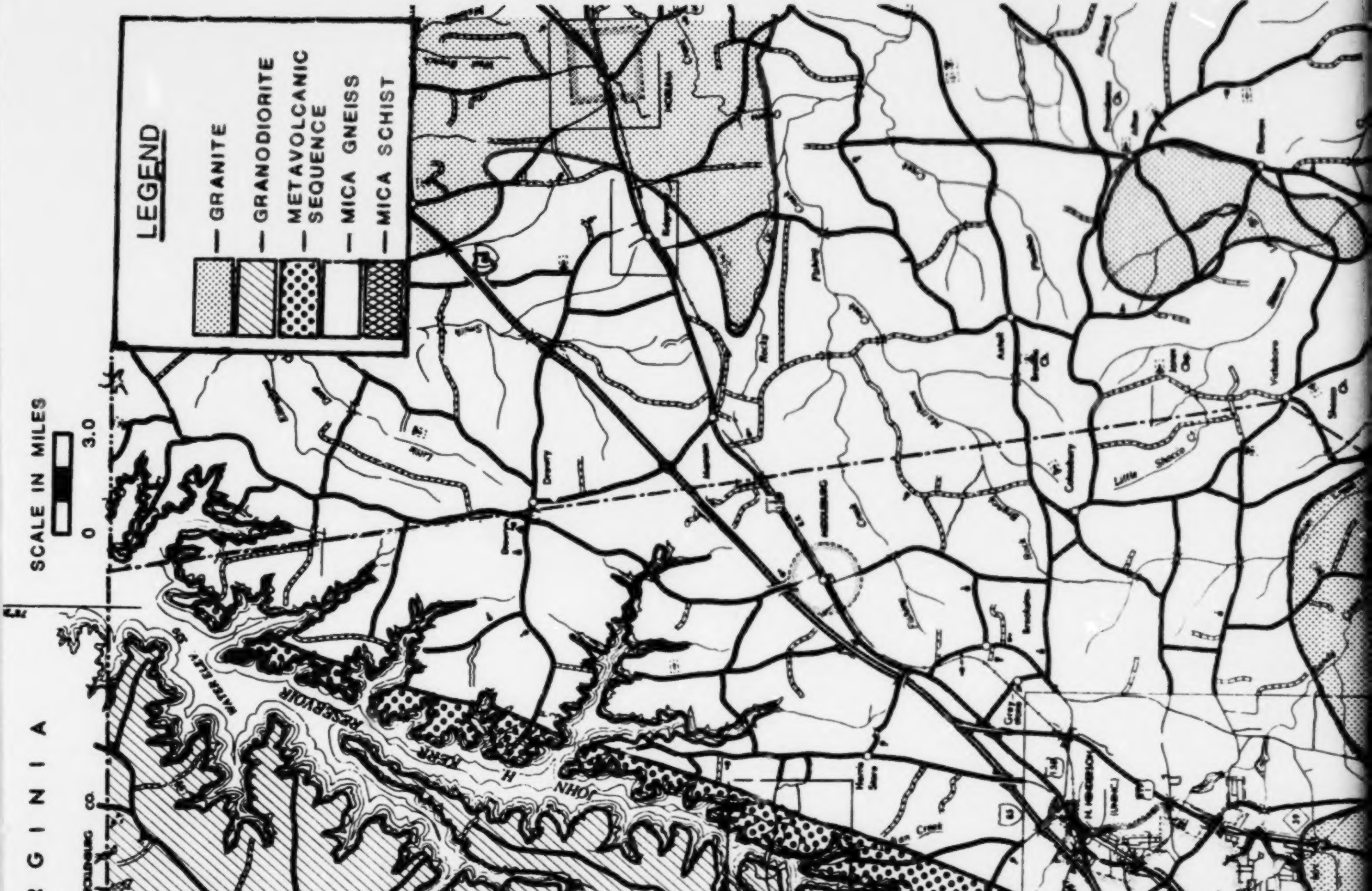
(1) Geology

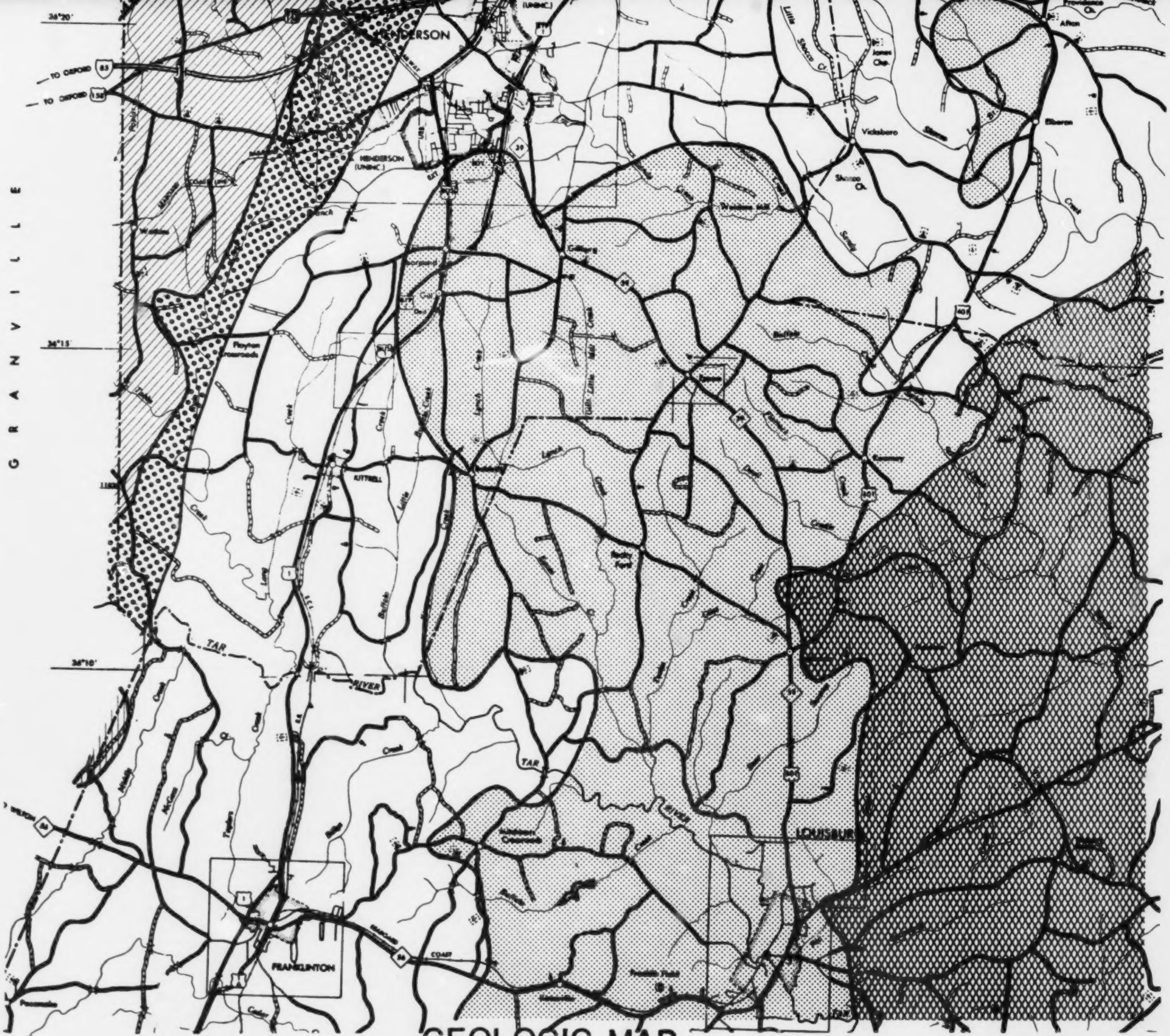
An understanding of the geologic setting is important to this environmental impact study. The geology, including rock types, their relationships to each other, and their associated characteristics, ultimately determines what activities of man can be supported. With respect to the proposed wastewater treatment facilities in particular, the geology of the area strongly influences both the soil types that are present in a specific area and the potential for ground-water development and pollution.

The area is characterized by rock units that are not dissimilar, and contacts between units are often gradational. A rather thick blanket of deeply weathered rock (saprolite) covers much of the area which further reduces the certainty with which the contacts are located. A generalized geologic map of the study area is presented in Figure II-4.

In general, the area is underlain by very old, folded gneisses and schists whose structural grain is northeastward. These rocks contain large intrusions of light-colored, chiefly granitic rocks of younger age which are present at the surface. Their emplacement uplifted much of the region so that overlying rock has been completely eroded.

In northwest Vance County and to the west of the study area in Granville County, rocks of mixed volcanic and sedimentary


LEGEND
GRANITE
GRANODIORITE
METAVOLCANIC SEQUENCE
MICA GNEISS
MICA SCHIST
SCALE IN MILES
0
3.0
VIRGINIA
MECKLENBURG CO.
JOHN H. KERR RESERVOIR
ISLAND CREEK RESERVOIR
HENDERSON
TO CLARKSVILLE
TO OXFORD
TO OXFORD
N
COUNTY


HENDERSON
HENDERSON (UNINC.)
TO OXFORD
TO OXFORD
GRANVILLE
36°20'
36°15'
36°10'
KITTRELL
TAR
RIVER
TAR
RIVER
FRANKLINTON
LOUISBURG
Vicksboro
Elberon
Little Shocco Cr.
Shocco Cr.
Sandy Creek
COAST

GEOLOGIC MAP
FIGURE II-4

origin are exposed at the surface. This unit, usually designated as a part of the Carolina Slate Belt, both flanks the study area and underlies other rocks in most of Vance County. Generally, the rocks of the east-southeast areas are older. The oldest rocks of the entire region are exposed only in eastern Warren and Franklin Counties, out of the study region.

No major faults exist in the study area. The study area is a region of low to moderate seismicity, with the area to the west slightly more prone to seismic damage than to the east. Earthquake potentials are probably due to relict compression and tension within the Blue Ridge Province to the west.

The probability of mass movement of geologic material in the study area is small; generally, natural slopes are in equilibrium and are stable. Perhaps the only area of concern in this respect is the artificial oversteepening of slopes by excavation or the truncation of a slope toe within thick, clayey residuum.

In general, there are few limitations on land use due to geologic factors. The depth of weathering is a key factor in determining the suitability of the land to support most uses, and most existing limitations are associated with thicker residual materials. At locations where the saprolite is thin, the moderate to high load-bearing and shear strength, the low shrink-swell potential, and the low compressibility combine to produce an environment suitable for practically any use. At locations where the saprolite is thick (particularly where the residuum is clayey), the lower strength, higher compressibility, poor drainage, and high shrink-swell potential cause problems for many uses. The soil layer itself imposes some restrictions on land usage that are important to wastewater treatment, such as septic tank operation and spray irrigation of effluents. These are discussed and the problem areas delineated in the following section.

(2) Soils

The major soil associations found in Vance County include the Cecil, Appling-Durham, Georgeville-Herndon, Appling-Louisburg, Helena-Vance-Enon, and Wilkes. General descriptions of these associations are presented in Table II-3. These various associations offer a wide range of suitability for urban and rural uses. Their areal distribution in the study area is shown in Figure II-5.

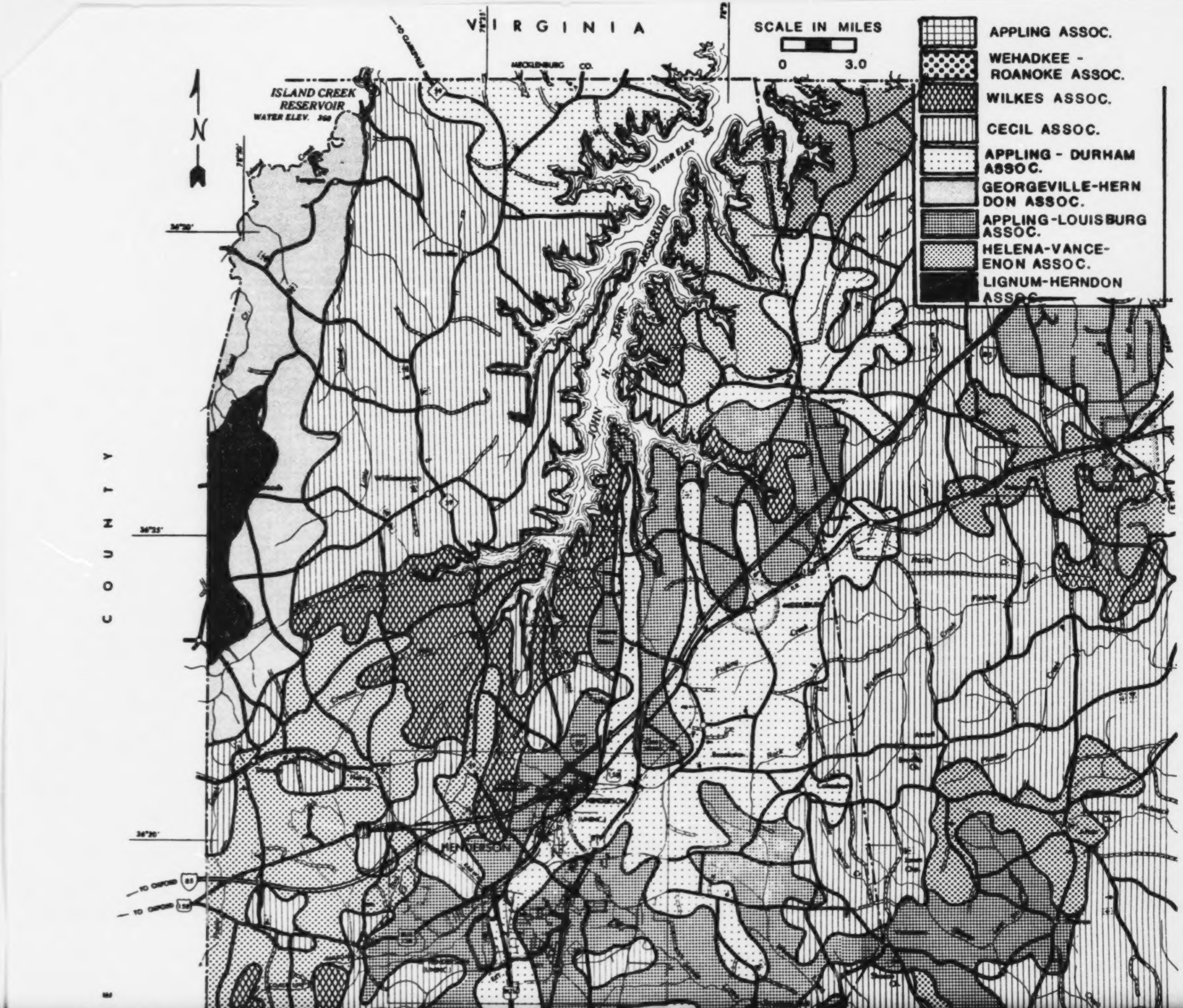
The estimated physical and chemical properties of the various major soils which comprise the soil associations located in the Vance County area are presented in Table II-4.

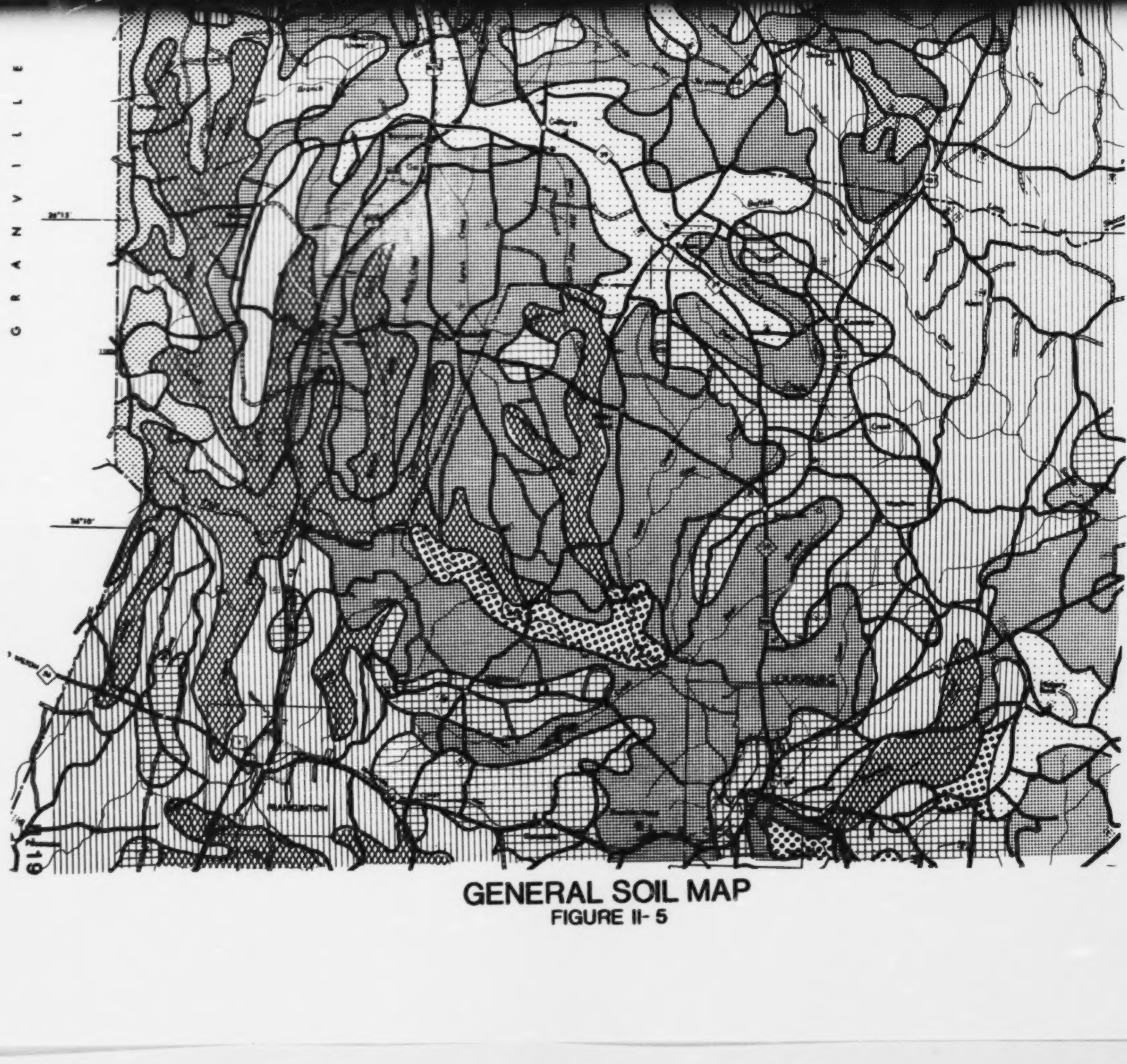
From descriptions of the soil associations and the estimated physical and chemical properties of the major soils in Vance County, suitable land uses can be determined for potential development of land resources. The degrees of suitability of the various soils for septic tank use, land disposal or treatment of sewage effluents and/or sludges, construction of small buildings, construction of roads and streets, general agriculture uses, and location of sanitary landfills are delineated in Figures II-6 through II-11. A rating of "good" indicates that the soils in the area have properties favorable for the rated use and that the unfavorable properties are minor and can be overcome easily. Good performance and low maintenance can be expected. A rating of "fair" indicates that the soil has a moderate number of unfavorable properties for the rated use. The unfavorable soil properties can be overcome or modified by special planning, design, and maintenance. A rating of "poor" indicates that the soil properties are generally unfavorable or unsuitable for the rated use. These soils will generally require major soil reclamation, special design, or intensive maintenance. These maps are of a general nature and are intended for broad planning only. Soils in any one association differ in slopes, thickness, wetness, and other characteristics which affect their use and management. These various parameters are not necessarily included in detail in these maps.

TABLE II-3

DESCRIPTION OF SOIL ASSOCIATIONS FOUND IN VANCE COUNTY

ASSOCIATION	TOPOGRAPHIC OCCURENCE	DISTRIBUTION		SOIL TEXTURE		COMMENTS
		SERIES	PERCENT	SURFACE LAYER	SUBSOIL	
Cecil	Broad gently sloping and sloping ridges with short moderately steep hillsides	Cecil	67%	Sandy loam and clay loam	Firm red clay	Well-drained
		Upland	33%		Very firm and very plastic	Well-drained
Appling-Durham	Broad gently sloping and sloping ridges with short sloping to moderately steep hillsides	Appling	74%	Sandy loam	Firm red clay	Well-drained
		Durham	9%	Sandy loam	Friable and yellowish	Well-drained
		Upland	17%			Well-drained, poorly developed and shallow to rock
Georgeville-Herndon	Fairly broad gently sloping ridges and short to moderately long sloping to moderately steep hillsides	Georgeville	61%	Silty loam to silty clay loam	Firm red clay	Well-drained
		Herndon	25%	Silty loam	Firm reddish to yellowish clay	Well-drained
		Upland	14%		Very firm and very plastic, poorly developed and shallow to rock	Well-drained
Appling-Louisburg	Intermediate and narrow gently sloping ridges and short to moderately long sloping to moderately steep hillsides	Appling	61%	Sandy loam	Firm red clay	Well-drained
		Louisburg	26%	Loamy sand	Friable, poorly developed, yellowish sandy loam	Shallow and excessively drained
		Upland	13%		Very firm and very plastic	Well-drained, poorly developed and shallow to rock
Helena-Vance-Enon	Fairly broad gently sloping ridges with short sloping hillsides	Helena	30%	Sandy loam	Friable sandy clay loam (upper), very mottled yellowish brown and gray and slowly permeable (lower)	Moderately well-drained
		Vance	26%	Sandy loam	Very firm and very plastic, slowly permeable, reddish to yellowish or brownish clay	Well-drained
		Enon	26%	Sandy loam or silt loam	Very firm and very plastic, yellowish or brownish, slowly permeable clay	Well-drained
		Upland	18%			Well-drained and friable, poorly-developed and shallow to rock
Lignum-Herndon	Fairly broad gently sloping ridges and short to long sloping to strongly sloping hillsides	Lignum	62%	Silty loam	Firm, mottled yellowish brown and gray silty clay	Moderately well-drained
		Herndon	25%	Silty loam	Firm yellowish red to yellowish brown clay	Well-drained
		Upland	13%		Very firm and very plastic	Well-drained; some poorly-developed and shallow to rock
Wilkes	Very narrow gently sloping ridges and sloping to moderately steep hillsides	Wilkes	76%	Sandy loam or silt loam	Yellowish brown to yellowish red clay	Well-drained and shallow
		Upland	24%		Some very firm and very plastic	Deep well-drained


VIRGINIA
MECKLENBURG CO.
TO CLARKSVILLE
ISLAND CREEK RESERVOIR
WATER ELEV.
N
JOHN H. KERR RESERVOIR
WATER ELEV.
SCALE IN MILES
0
3.0
APPLING ASSOC.
WEHADKEE - ROANOKE ASSOC.
WILKES ASSOC.
CECIL ASSOC.
APPLING - DURHAM ASSOC.
GEORGEVILLE-HERNDON ASSOC.
APPLING-LOUISBURG ASSOC.
HELENA-VANCE-ENON ASSOC.
LIGNUM-HERNDON ASSOC.
36°30'
36°25'
36°20'
HENDERSON
TO OXFORD
TO OXFORD
COUNTY



GENERAL SOIL MAP
FIGURE II- 5

TABLE II-4

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES OF MAJOR SOILS FOUND IN VANCE COUNTY, NORTH CAROLINA

Soil Type	General Soil Profile (Inches)	Classification			Coarse Fract. >3 in. %	Percentage Less Than 3 Inches Passing Sieve No. --				LL	PI	Permeability in/hr.	Avail. Water Cap. in/hr.	Soil Reaction	Shrink-Swell Potential	Depth To Rock ft	Flood Hazard	Ft to High Water Table
		USDA Texture	Unified	AASHO		4	10	40	200									
Appling	0-10	cosl,sl,fsl	SM,SM-SC	A-2	--	96-100	84-97	55-87	32-35	NP-27	NP-5	2.0-6.3	.11-.13	4.5-5.5	low	>5	none	>5
	0-10	grsl	GM,GP-GM	A-1	--	40-45	35-45	25-40	10-15	NP	NP	>6.3	.07-.09	4.5-5.5	low			
	0-10	cl	CL,ML	A-6	--	95-100	85-100	70-95	50-70	10-20	20-30	.63-2.0	.12-.14	4.5-5.5	med.			
	10-54	c,sc	MH	A-7	--	100	88-100	70-92	55-75	60-74	25-28	.63-2.0	.12-.14	4.5-5.5	med.			
	54-60	scl,cl,sl	SM,ML,MH	A-5	--	100	98-100	71-86	46-57	42-54	NP-14	.63-2.0	.12-.14	4.5-5.5	med.			
Cecil	0-7	sl,fsl,l	SM,SM-SC	A-2,A-4	0	84-100	80-100	67-90	26-42	< 30	NP-6	2.0-6.0	.12-.14	4.5-6.0	low	>5	none	>6
	0-7	cr-sl	GM,GM-GC SM,SM-SC	A-2,A-1	0	40-75	35-72	25-60	13-28	< 22	NP-6	6.0-20	.07-.09	4.5-6.0	low			
	0-7	scl,cl,	SM,SC,CL ML	A-6	0	74-100	72-100	68-95	38-81	21-28	3-10	0.6-2.0	.13-.15	5.5-6.0	low			
	7-50	c	MH,ML	A-7	0	97-100	92-100	72-99	55-95	41-80	9-37	0.6-2.0	.13-.15	4.5-5.5	med			
	50-75	wb																
Durham	0-16	ls,sl,fsl	SM	A-2,A-4	--	100	98-100	60-70	24-36	NP-11	NP	2.0-6.3	.08-.10	5.1-6.0	low	>5	none	>10
	16-48	scl	SM,SC	A-7,A-6	--	100	98-100	64-69	44-49	35-53	15-21	.63-2.0	.12-.16	5.1-5.5	low-med			
	48-56+	sl	SM	A-2,A-4	--	100	99-100	67-73	23-44	NP	NP	.63-2.0	.10-.12	5.1-5.5	low			
Enon	0-7	fsl,sl	SM,SC	A-4,A-2	--	100	100	75-85	30-50	--	NP	2.0-6.3	.11-.13	6.1-6.5	low	>5	none	>5
	0-7	cl	CL	A-6	--	100	100	80-100	50-80	20-60	10-20	.63-2.0	.13-.15	6.1-7.3	low			
	7-34	c	CH,MH	A-7	--	100	100	90-100	75-95	55-83	27-47	.06-.20	.13-.15	6.1-7.3	high			
	34-50+	cl	CL,CH SM,SC	A-6,A-2	--	100	100	90-100	30-80	NP-64	NP-18	.06-.20	.13-.15	6.6-7.3	med			
Helena	0-12	sl,fsl	SM	A-2,A-4	--	100	98-100	51-86	27-46	16-25	NP-2	2.0-6.3	.10-.12	4.5-6.0	low	>6	none	>6
	0-12	ls	SM	A-2	--	100	95-100	55-65	10-30	10-15	NP	>6.3	.07-.09	4.5-6.0	low			
	12-19	scl,cl	CL	A-7,A-6	--	95-100	95-100	70-90	55-70	33-65	25-30	0.20-0.63	.13-.15	4.5-5.5	med-high			
	19-46	c,sc	CH	A-7	--	99-100	95-98	73-93	56-76	50-69	25-40	<.2	.13-.15	4.5-5.5	high			
	46-60	sl	SM	A-4	--	100	96-100	73-82	45-56	25-35	10-20	0.2-.63	.11-.13	4.5-5.5	med.			
Louisburg	0-7	ls,sl	SM	A-2	0-30	95-100	90-100	55-70	15-35	-	NP	6.0-15.0	.05-.08	4.5-6.0	low	2-6	none	none
	7-24	sl,ls	SM	A-2,A-4	0-20	85-95	75-100	40-70	20-40	0-21	NP	6.0-12.0	.06-.10	4.5-6.0	low			
	24-60	svlt	-	-	-	-	-	-	-	-	-	-	-	-	-			
Vance	0-6	csl,sl,fsl	SM	A-2	--	92-98	88-96	69-75	22-33	--	NP	2.0-6.3	.10-.12	4.5-6.0	low	>6	none	>6
	6-40	c,sc	MH,MH-CH	A-7	--	--	100	80-93	69-81	66-80	25-44	.06-.20	.12-.16	4.5-5.5	mod.			
	40-60	scl, l,sc	ML,MH,SC	A-5,A-7	--	--	100	71-91	48-66	41-50	9-21	.06-.20	.12-.16	4.5-5.5	med.			
Wilkes	0-6	sl,l,scl	SM,CL,CH	A-7	--	95-100	95-100	70-85	65-60	41-55	15-25	.6-2.0	.11-.15	5.6-7.8	low	1-4	none	>6
	0-6	gr,sl,gr,l	SM,SC, SM-SC	A-2,A-6	5-15	70-80	60-75	65-75	20-50	20-35	NP-15	2.0-6.0	.08-.10	5.6-7.8	low			
	6-13	cl,scl	MH,CH	A-7	--	100	95-100	90-95	55-70	45-60	20-35	.02-.6	.12-.18	5.6-7.8	med.			
	13-40	cl,l	CL,MH,CH	A-7	---	100	95-100	85-95	50-65	41-55	15-25	.02-.6	.15-.17	5.6-7.8	med.			
	40	Hard bedrock																

TABLE II-4 (Cont.)

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES OF MAJOR SOILS FOUND IN VANCE COUNTY, NORTH CAROLINA

Soil Classifications

USDA

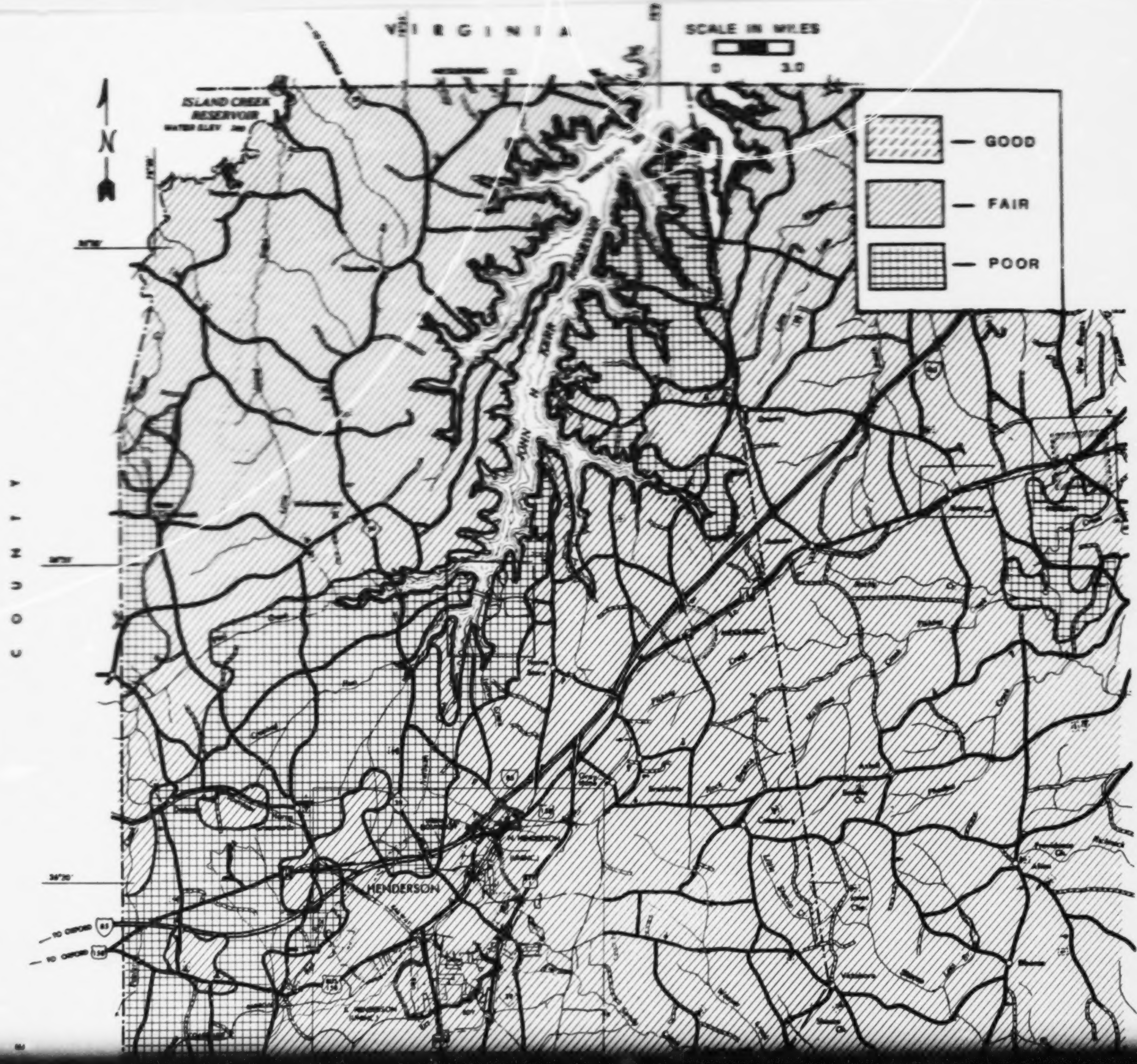
sl - sandy loam or silty loam
fsl - fine sandy loam or fine silty loam
cl - clay loam
sc - sandy clay or silty clay
c - clay
ls - loamy sand
scl - sandy clay loam or silty clay loam

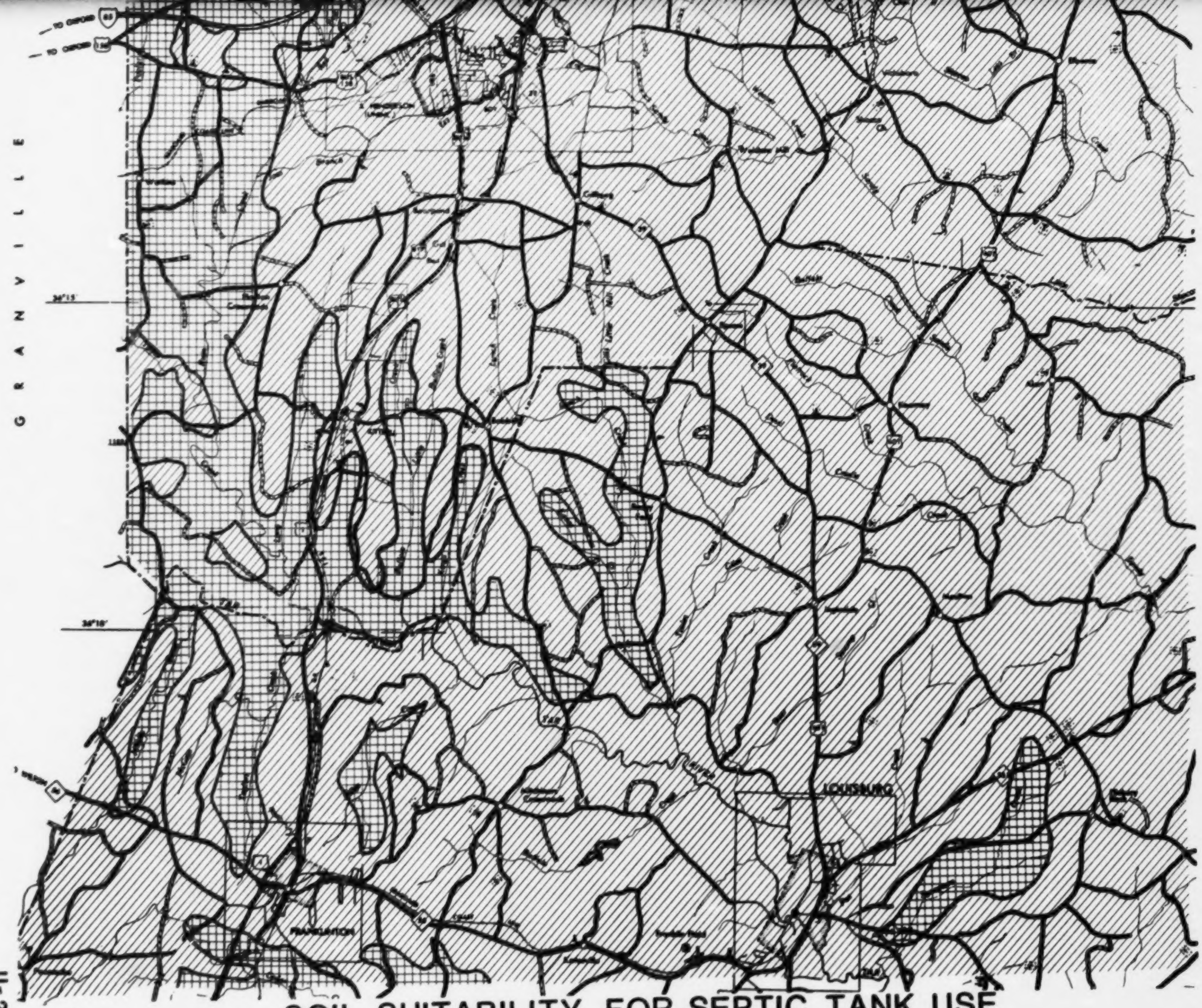
UNIFIED

GW - Well-graded gravels, gravel-sand mixtures, little or no fines
GP - Poorly-graded gravels or gravel-sand mixtures, little or no fines
GM - Silty gravels, gravel-and-silt mixtures
GC - Clayey gravels, gravel-sand-clay mixtures
SW - Well-graded sands, gravelly sands, little or no fines
SP - Poorly-graded sands or gravelly sands, little or no fines
SM - Silty sands, sand-silt mixtures
SC - Clayey sands, sand-clay mixtures
ML - Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
CL - Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
OL - Organic silts and organic silty clays of low plasticity
MH - Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
CH - Inorganic clays of high plasticity, fat clays
OH - Organic clays of medium to high plasticity, organic silts
Pt - Peat and other high organic soils

AASHO

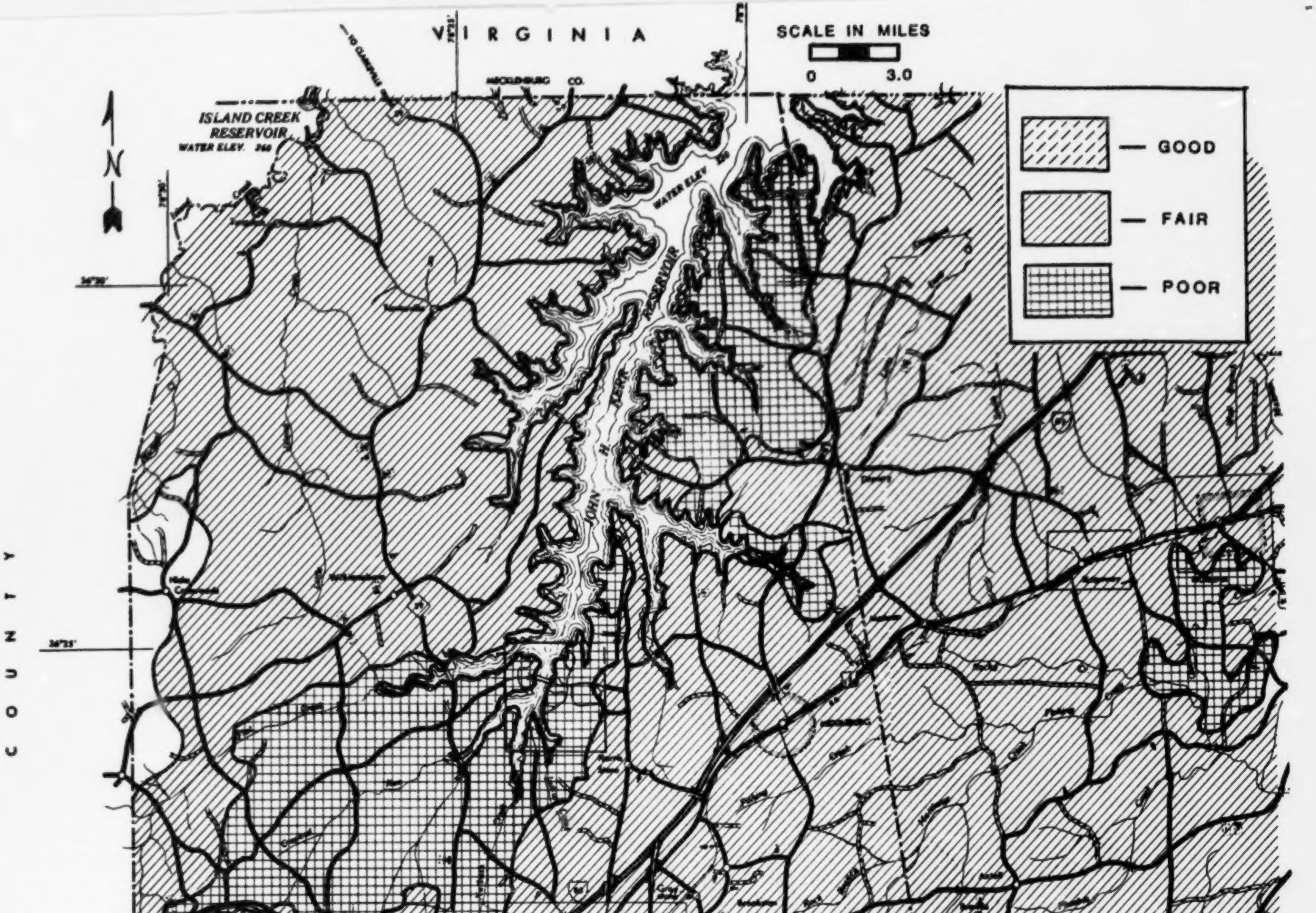
A-1 - Well-graded mixture of stone fragments or gravel, coarse sand, fine sand, and a non-plastic or freely plastic soil binder; also stone fragments, gravel, coarse sand volcanic cinders, etc., without soil binder
A-3 - Fine beach sand or fine desert blow sand without silty or clayey fines or with a very small amount of non-plastic silt; also stream-deposited mixtures of poorly-graded fine sand and limited amounts of coarse sand and gravel
A-2 - Wide variety of granular materials which borderline materials in Groups A-1 and A-3 and the silt-clay materials of Groups A-4 through A-7
A-4 - Non-plastic or moderately plastic silty soil 75% or more of which usually passes the No. 200 sieve; also mixtures of fine silty soil and up to 64% of sand and gravel retained on the No. 200 sieve.
A-5 - Similar to Group A-4 except usually of diatomaceous or micaceous character and may be highly elastic
A-6 - Plastic clay soil 75% or more passing the No. 200 sieve; also mixtures of fine clayey soil and up to 64% of sand and gravel retained on the No. 200 sieve
A-7 - Similar to Group A-6 but has a high liquid limit similar to Group A-5 and may be elastic
A-8 - Peat or muck soil found in unstable, swampy areas.


VIRGINIA
SCALE IN MILES
0
3.0
GOOD
FAIR
POOR
ISLAND CREEK RESERVOIR
WATER ELEV
N
36°20'
COUNTY
JOHN H. KERR RESERVOIR
HENDERSON
TO OXFORD
85
TO OXFORD
158


TO OXFORD
TO OXFORD
GRANVILLE
36°15'
36°10'
LOUISBURG
FRANKLINTON

SOIL SUITABILITY FOR SEPTIC TANK USE

FIGURE II-6


VIRGINIA
SCALE IN MILES
0
3.0
GOOD
FAIR
POOR
ISLAND CREEK RESERVOIR
WATER ELEV. 260
MECKLENBURG CO.
TO CLARKSVILLE
JOHN H. KERR RESERVOIR
WATER ELEV.
N
COUNTY
36°30'
36°25'
36°20'
HENDERSON
TO OXFORD
TO OXFORD

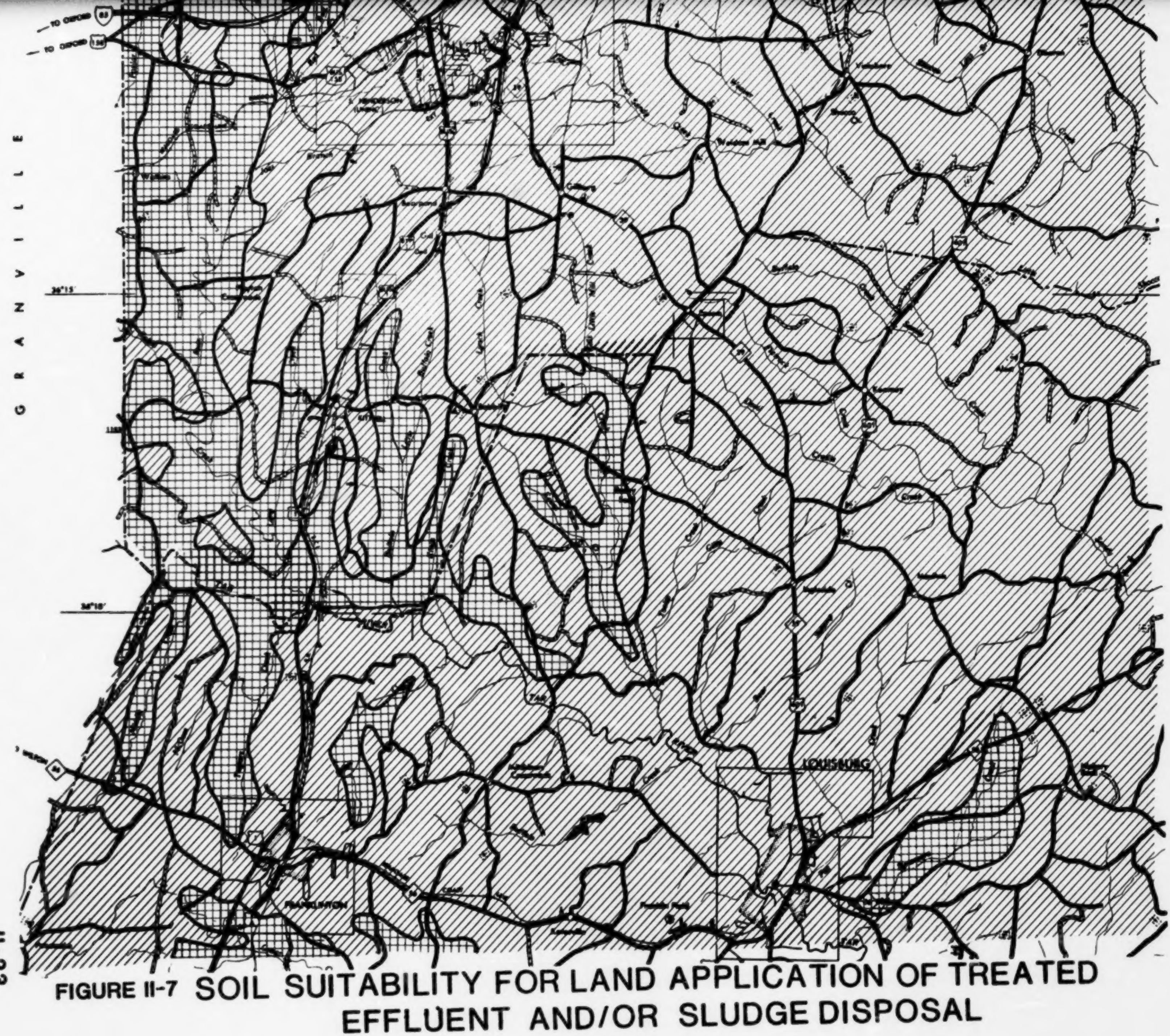
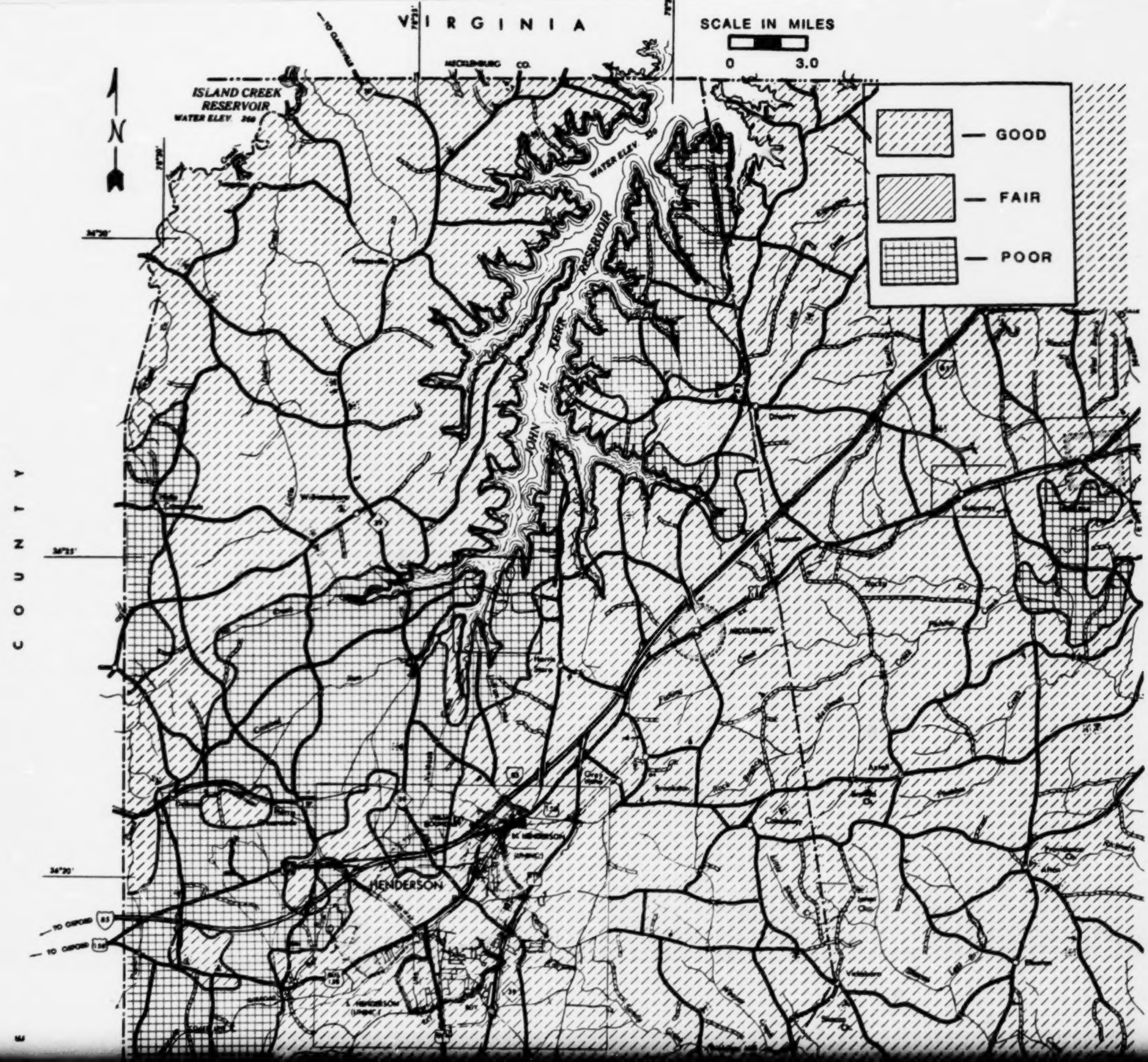
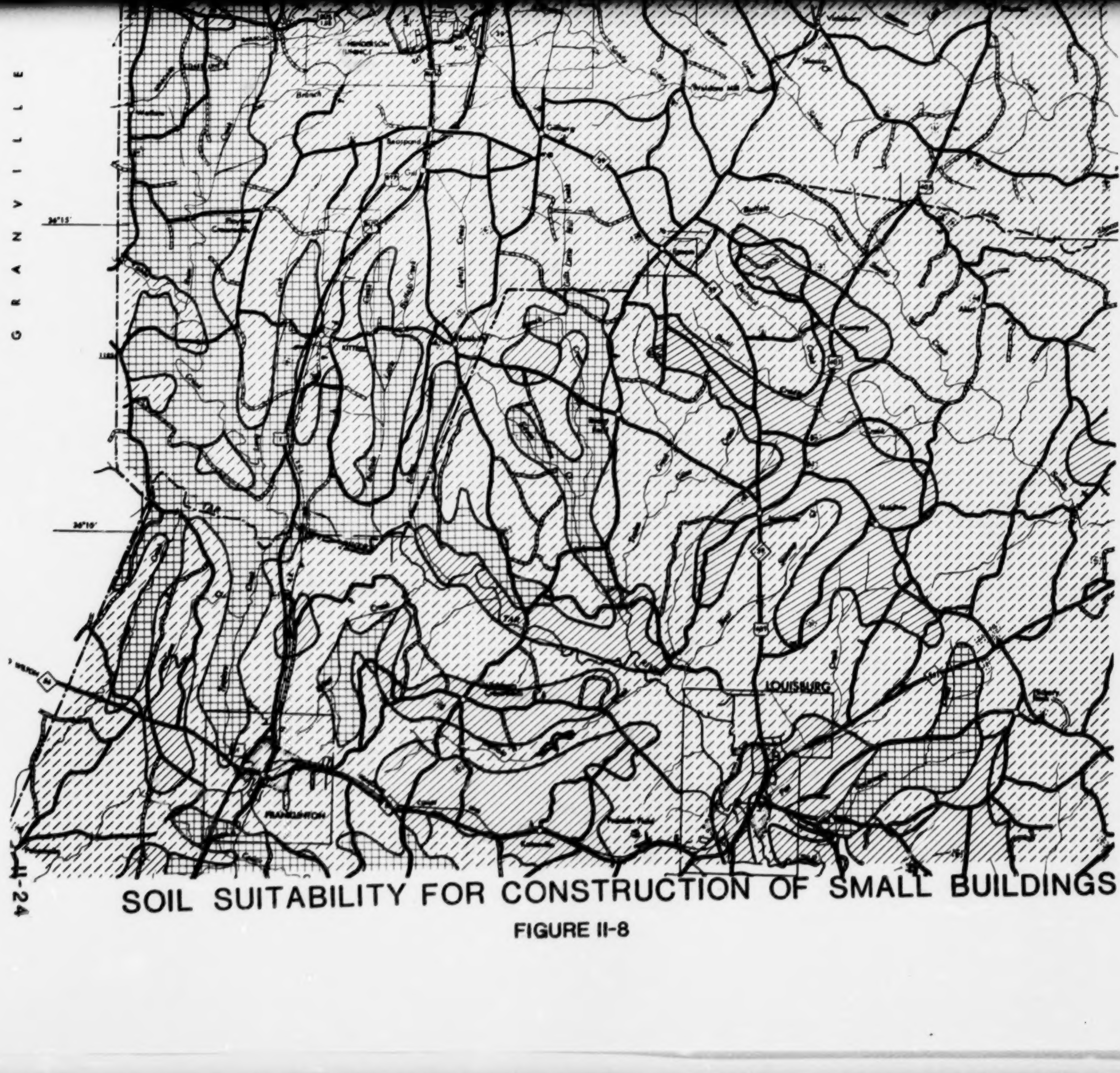

G R A N V I L L E
TO OXFORD
TO OXFORD
36°15'
36°10'
LOUISBURG
FRANKLINTON

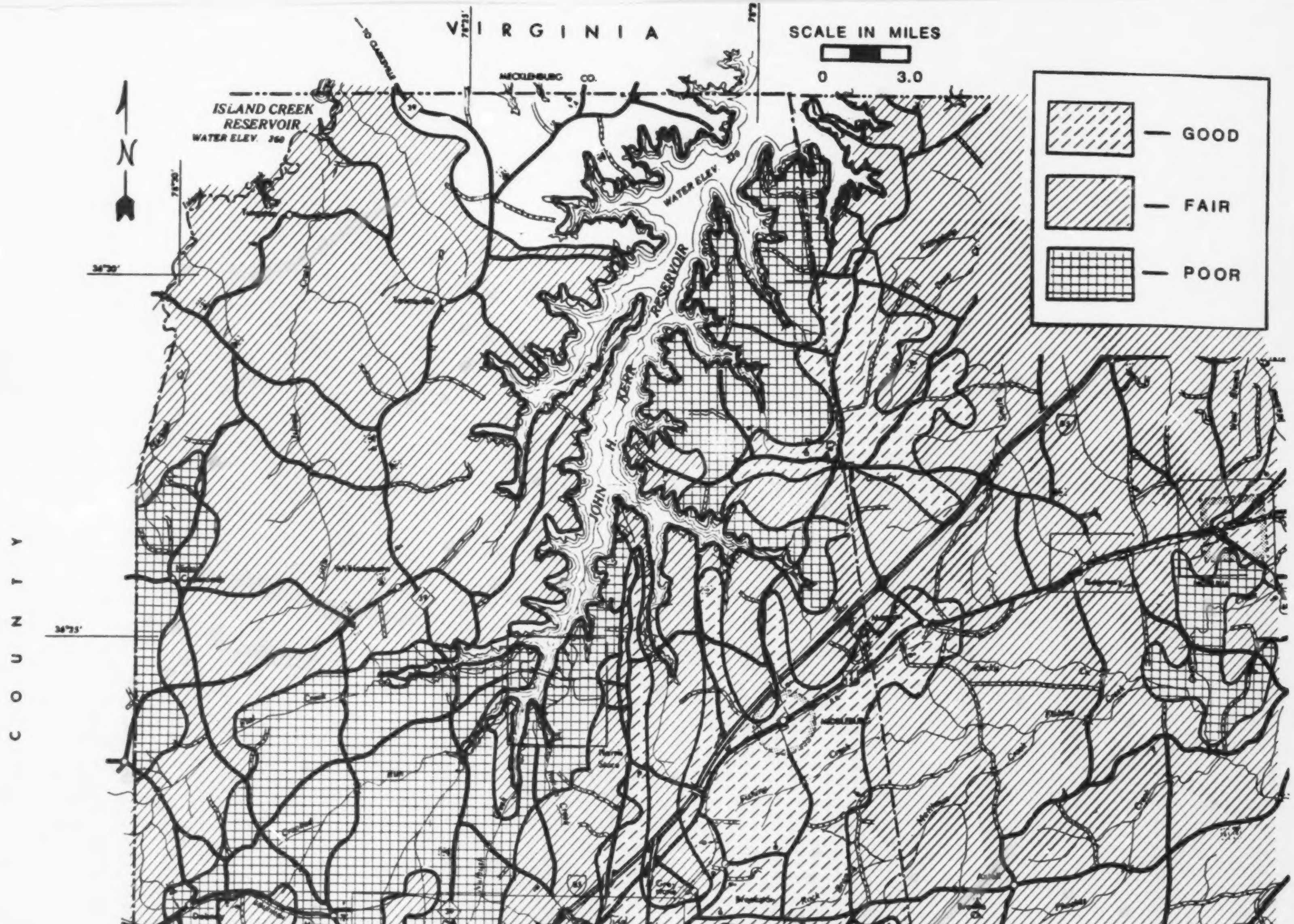
FIGURE II-7 SOIL SUITABILITY FOR LAND APPLICATION OF TREATED EFFLUENT AND/OR SLUDGE DISPOSAL


VIRGINIA
SCALE IN MILES
0
3.0
GOOD
FAIR
POOR
ISLAND CREEK RESERVOIR
WATER ELEV.
MECKLENBURG CO.
JOHN H. KERR RESERVOIR
WATER ELEV.
HENDERSON
TO OXFORD
TO OXFORD
N
36°30'
36°25'
36°20'
COUNTY


GRANVILLE
36°15'
36°10'
HENDERSON
LOUISBURG
FRANKLINTON

SOIL SUITABILITY FOR CONSTRUCTION OF SMALL BUILDINGS

FIGURE II-8

VIRGINIA
SCALE IN MILES
0
3.0
GOOD
FAIR
POOR
ISLAND CREEK RESERVOIR
WATER ELEV. 260
MECKLENBURG CO.
TO CLARKSVILLE
JOHN H. KERR RESERVOIR
WATER ELEV.
HENDERSON
TO OXFORD
TO OXFORD
COUNTY
E
N
78°25'
78°20'
36°30'
36°25'
36°20'

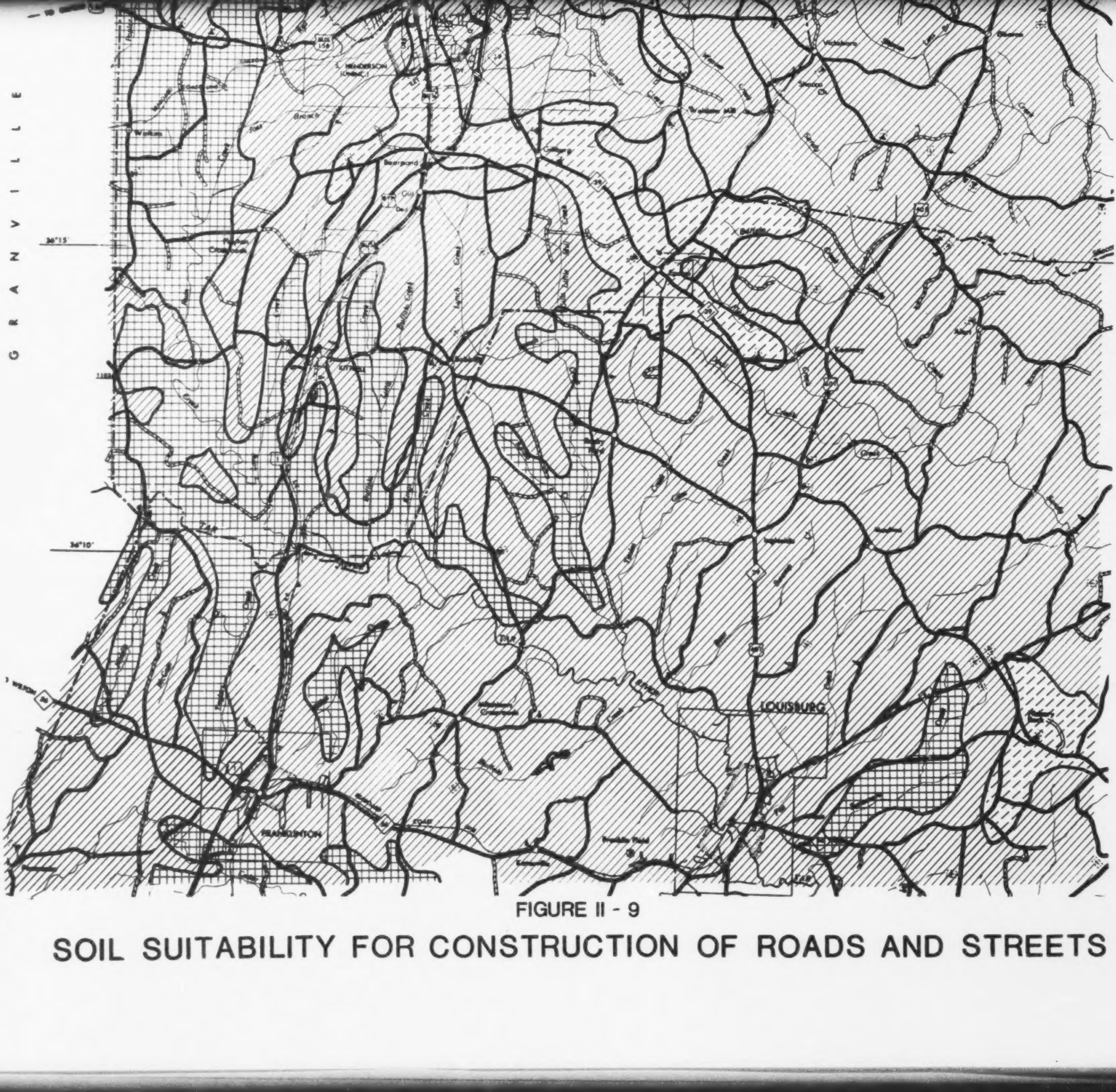
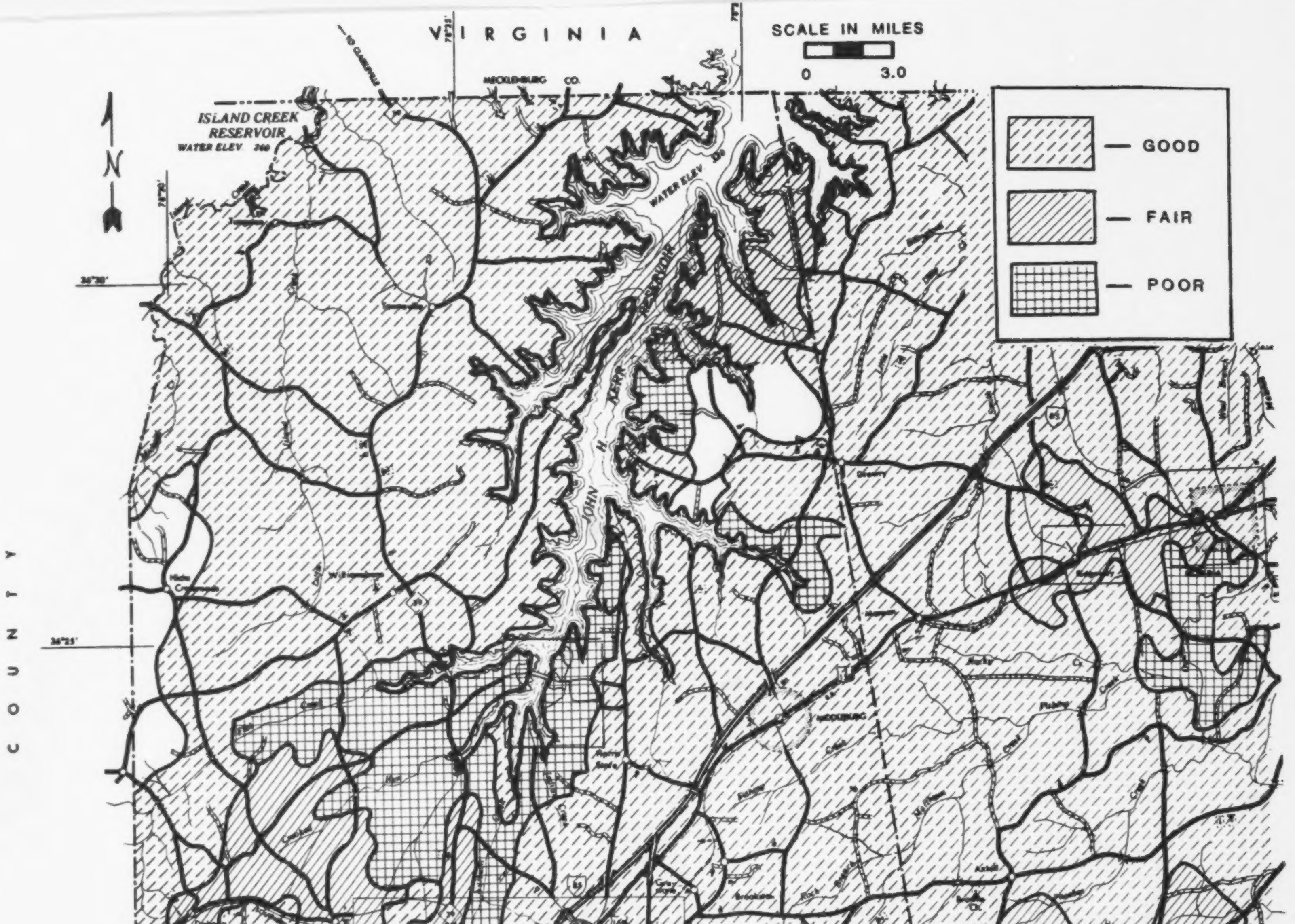
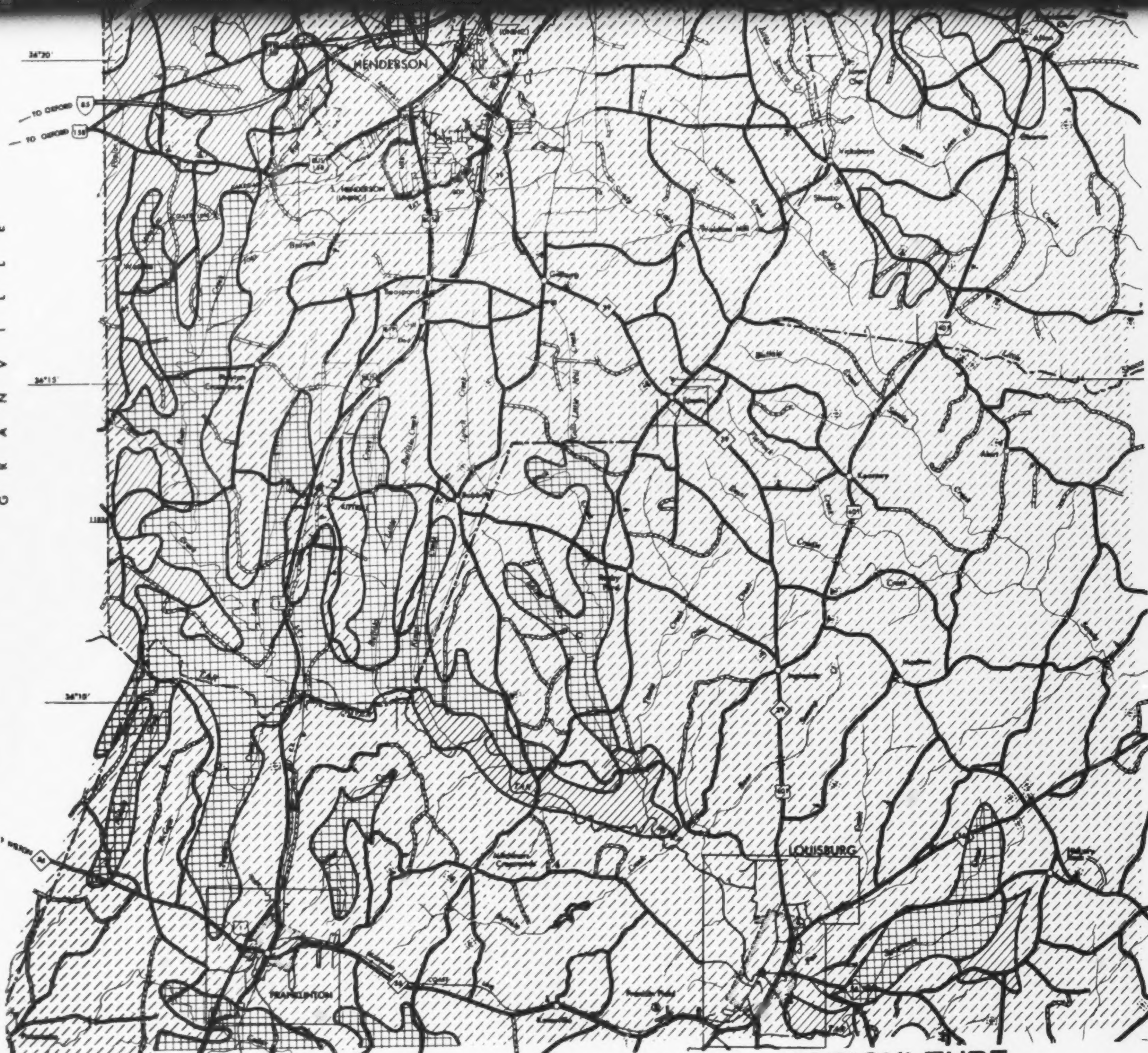

GRANVILLE
HENDERSON
LOUISBURG
FRANKLINTON
36°15'
36°10'

FIGURE II - 9

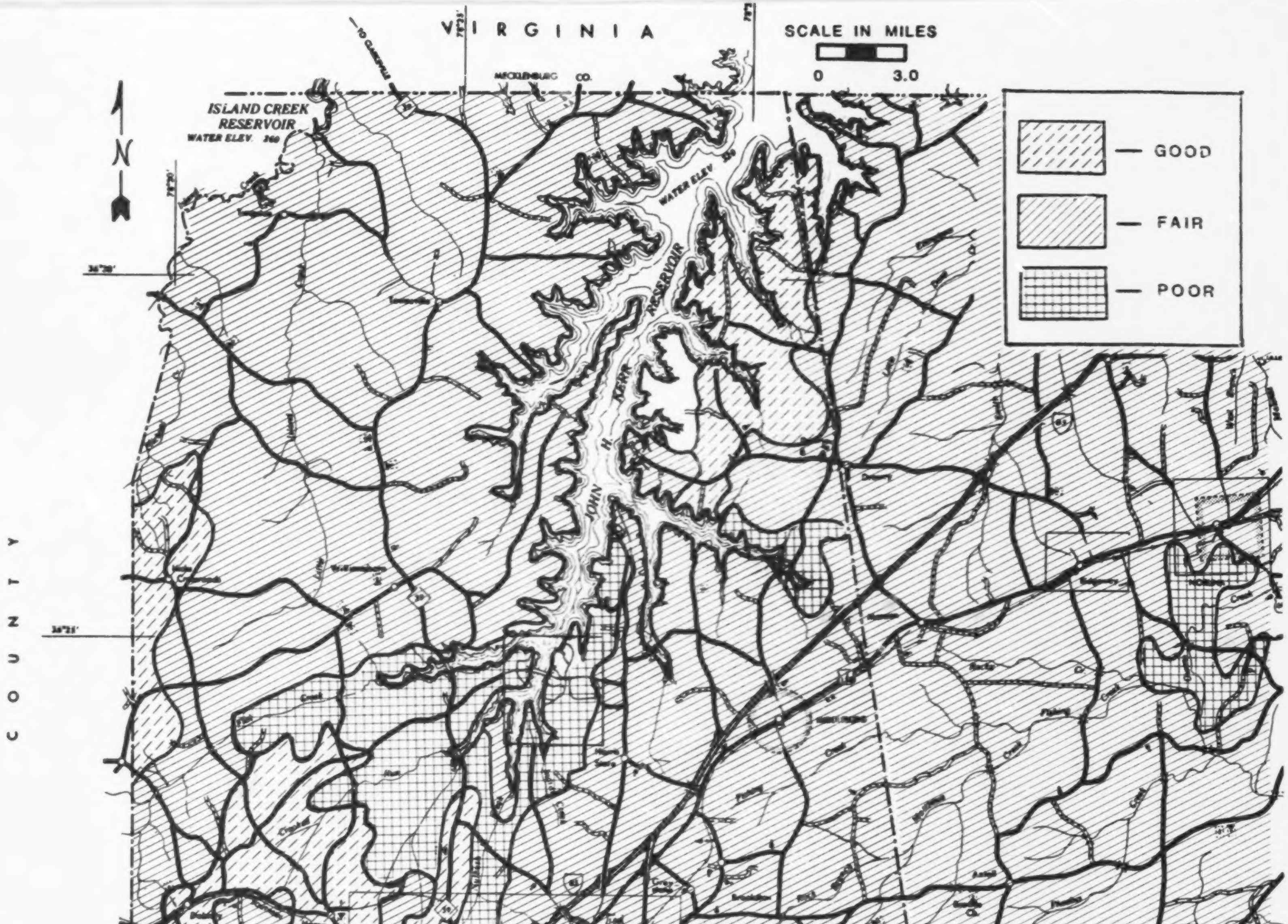
SOIL SUITABILITY FOR CONSTRUCTION OF ROADS AND STREETS

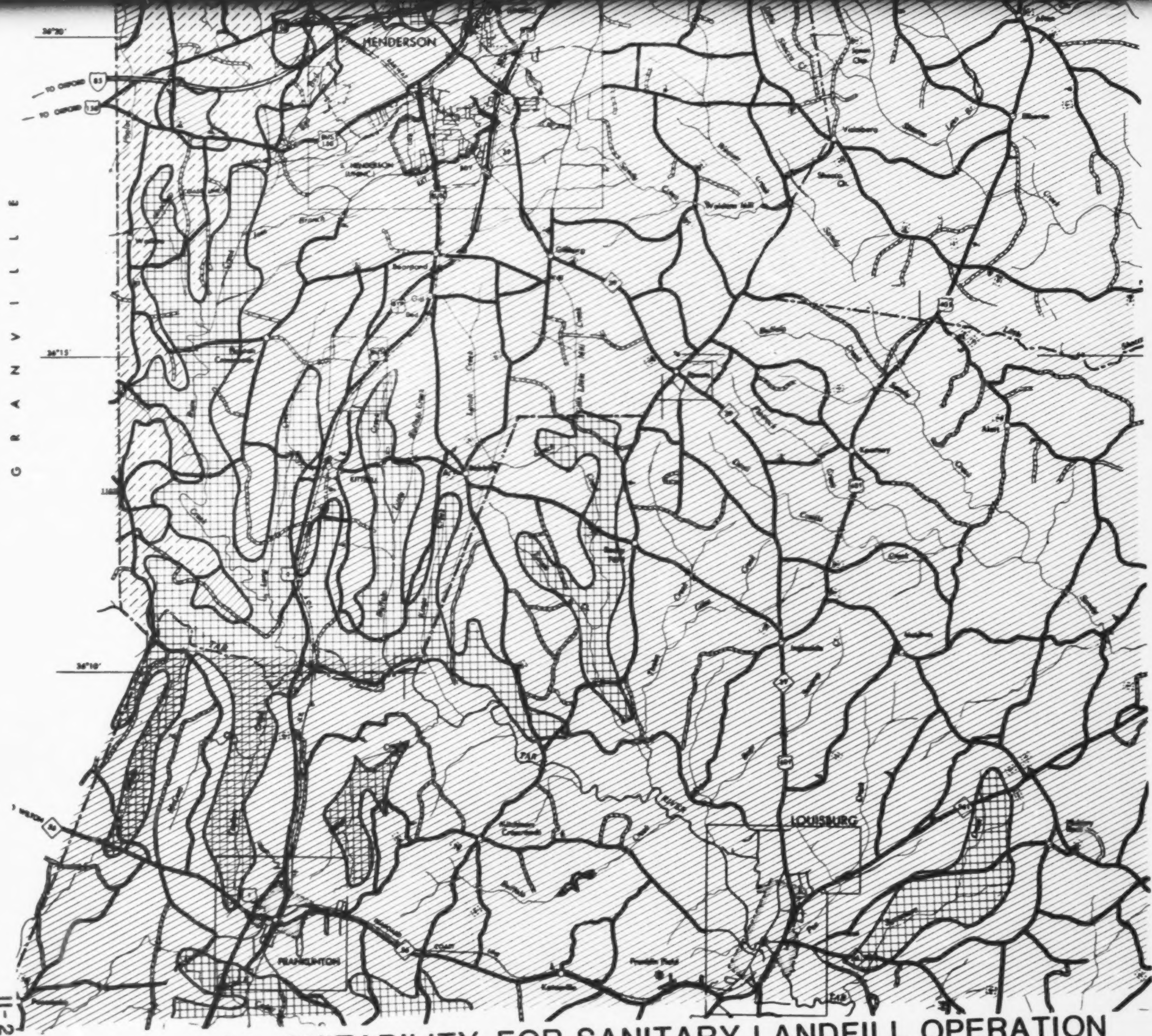

VIRGINIA
SCALE IN MILES
0
3.0
GOOD
FAIR
POOR
ISLAND CREEK RESERVOIR
WATER ELEV 260
MECKLENBURG CO.
JOHN H. KERR RESERVOIR
WATER ELEV.
TO CLARKSVILLE
36°30'
36°25'
36°20'
HENDERSON
N. HENDERSON
MIDDLEBURG
TO OXFORD
TO OXFORD
COUNTY
N


GRANVILLE
HENDERSON
TO OXFORD 85
TO OXFORD 158
36°20'
36°15'
36°10'
LOUISBURG
FRANKLINTON
TAR
401
39
56

SOIL SUITABILITY FOR GENERAL AGRICULTURE

FIGURE II-10


VIRGINIA
SCALE IN MILES
0
3.0
GOOD
FAIR
POOR
N
ISLAND CREEK RESERVOIR
WATER ELEV. 260
MECKLENBURG CO.
TO CLARKSVILLE
JOHN H. KERR RESERVOIR
WATER ELEV.
HENDERSON
TO OXFORD
TO OXFORD
COUNTY
36°30'
36°25'
36°20'


HENDERSON
LOUISBURG
FRANKLINTON
G R A N V I L L E
TO OXFORD
TO OXFORD
36°20'
36°15'
36°10'
TAR

SOIL SUITABILITY FOR SANITARY LANDFILL OPERATION

FIGURE II-11

c. Water

(1) Physical and Chemical Aspects

General Considerations

Both the surface and subsurface drainage systems are of interest to the environmental assessment. In this overview, they are generally described for subsequent characterization.

Surface Drainage System

The area under investigation is drained by both the Roanoke and Tar Rivers as shown in Figure II-3. Most of the smaller surface streams have moderate to high gradients, but the larger streams in the area, especially the Tar River and lower Sandy Creek, have low gradients. The floodplains of streams are generally narrow, although the Tar River and the lower parts of Tabbs and Ruin Creek have substantially wider floodplains than other streams.

There are no important natural lakes in the area. There are numerous small to medium-sized headwater impoundments that in themselves are rather inconsequential to the surface-water hydrologic regime. The most important impoundments are the series of ponds on upper Sandy Creek that are currently operated as Henderson's water supply and the Nutbush Creek embayment of Kerr Reservoir. The Sandy Creek ponds, including Fox Reservoir (Henderson City Lake), Roland Pond, Club (Ellis') Pond, Weldon's Pond, and Southerland's Pond, in aggregate provide a storage capacity of 80+ million gallons. The Sandy Creek ponds water supply became a supplementary supply in the fall of 1976 when a new regional public supply system using water from the Nutbush arm of Kerr Reservoir became operational.

John H. Kerr Reservoir dam was completed in 1952 as a multi-purpose project for flood control, hydroelectric power generation, fish and wildlife enhancement, water quality control, recreation, and other purposes, now including a regional public raw water supply. Nutbush Creek is the smaller of two major arms of the reservoir, and comprises over 12,000 acres of water surface at maximum power pool. The mean depth of the Nutbush arm is just under 30 feet. Owing to the normally low inflows to this part of the reservoir (115 cfs from all sources), the detention time afforded by the water body is very large (about 1,800 days). This long detention time is important to the limnological aging process, as described in a subsequent subsection.

During early summer to late fall, the water column of Kerr Reservoir, including the upper Nutbush arm, thermally stratifies in spite of hydropower withdrawals. A 10°C temperature differential between top and bottom develops gradually from May to August, with the thermocline ultimately lying between 40 and 50 feet in the main reservoir and between 10 to 15 feet in the upper arms. The hypolimnion contains low dissolved oxygen for several months. The fall overturn occurs late in November and the reservoir is generally well-mixed by early December. Water temperatures seldom fall below 4°C in the period from December through February. As early as mid-March, a 2°C temperature differential at depths of 70 to 80 feet may develop in the main reservoir, presaging the subsequent stratification even though that stratification of the lake is areally continuous during the summer, with pronounced thermal gradients even in relatively shallow waters of embayments.

Subsurface Drainage System

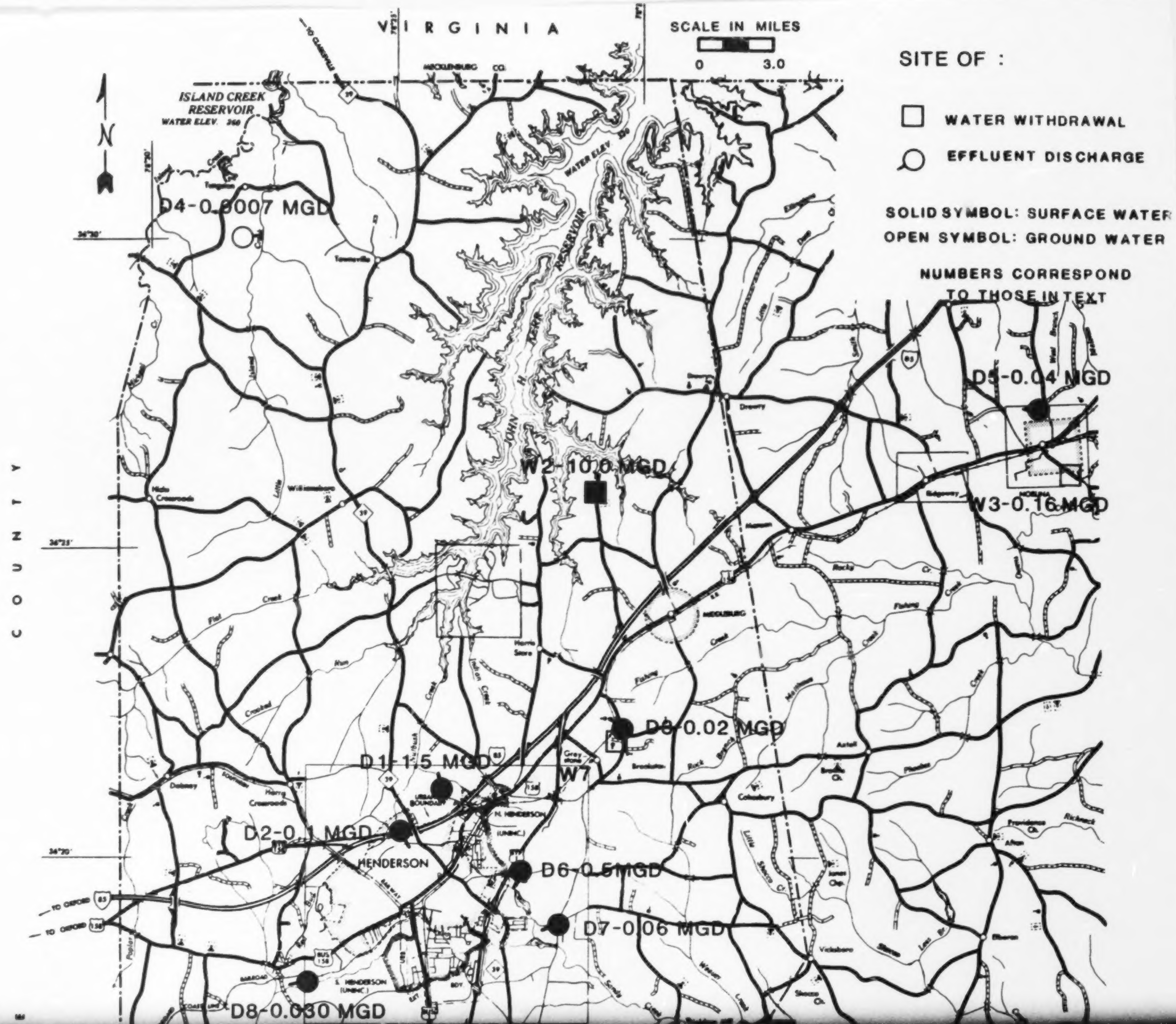
Only relatively small amounts of ground water exist in the area. Much of the water infiltrates the soil, forms subsurface runoff to surface streams during wet periods, and is not true ground water in a saturated zone. Most of this water is contained in the saprolite which mantles virtually the entire region (except in the stream channels). This saprolite will yield very small but often sufficient quantities of water to wells, so it represents a generally available, if poor, aquifer. The "recharge area" for this aquifer is essentially the entire region, and the water discharges generally to non-ephemeral surface drainageways. Some of the water in this aquifer moves downward into the more unweathered bedrock which is another aquifer in its upper part. The recharge area for the bedrock aquifer is the area covered by saprolite, particularly thicker saprolite on the interstream uplands. Consequently, the recharge areas for the residuum and bedrock aquifers are essentially congruent. Similarly, the bedrock aquifer also discharges to the stream valleys or other topographically depressed areas, as ground water in the aquifer moves from areas of higher elevation to lower elevation. Such ground-water discharge is usually by seepage, and rarely by springs. The subsurface drainage system constitutes, then, a hydraulically connected system of chiefly unconfined (i.e., water-table) to (locally) leaky artesian aquifers.

Besides discharge to surface streams, ground water is also discharged naturally by evaporation from the soil and by transpiration by vegetation, particularly in the hot summer months when vegetative growth is most active. Evapotranspiration is especially important in those heavily wooded areas where ground water is close to the land surface. Its efficiency as an avenue for discharge is marked by the general decline of water levels to a low point in early fall. Ensuing late fall and winter rains rapidly recharge the bedrock aquifer by increasing the amount of water in storage in the overlying saprolite, which in turn increases leakage recharge to the bedrock aquifer.

Water Usage for Supply and Discharge

The map of the study area in Figure II-12 designates significant areas and rates of water withdrawal from surface-water and ground-water supplies and points and average rates of discharge of municipal and industrial effluent to surface streams. No wastewaters, other than septic tank effluent, are currently discharged to ground water. Direct discharge of wastewater to ground-water bodies by well injection or percolation pits is generally not feasible at any location, owing to the limited capacity of the ground-water reservoir to transmit or store fluids.

Of special interest to this assessment are the public water supplies of the town of Louisburg from the Tar River, the new regional water supply on Kerr Reservoir for the municipalities of Oxford, Henderson, and Soul City, and the Norlina and Kittrell public water supplies from ground water in a bedrock aquifer. Points of significant wastewaters discharge, other than those of the City of Henderson, are restricted to industrial effluent contributions directly to Nutbush Creek at Henderson.


V I R G I N I A
MECKLENBURG CO.
SCALE IN MILES
0
3.0
SITE OF :
WATER WITHDRAWAL
EFFLUENT DISCHARGE
SOLID SYMBOL: SURFACE WATER
OPEN SYMBOL: GROUND WATER
NUMBERS CORRESPOND
TO THOSE IN TEXT
ISLAND CREEK
RESERVOIR
WATER ELEV. 260
JOHN H. KERR RESERVOIR
N
C O U N T Y
D4-0.0007 MGD
D5-0.04 MGD
W3-0.16 MGD
W2-10.0 MGD
D8-0.02 MGD
D1-1.5 MGD
W7
D2-0.1 MGD
D6-0.5 MGD
D7-0.06 MGD
D8-0.030 MGD
HENDERSON
N. HENDERSON (UNINC.)
S. HENDERSON (UNINC.)
MIDDLEBURG
NORLINA
TO OXFORD
TO OXFORD
TO CLARKSVILLE
36°30'
36°25'
36°20'

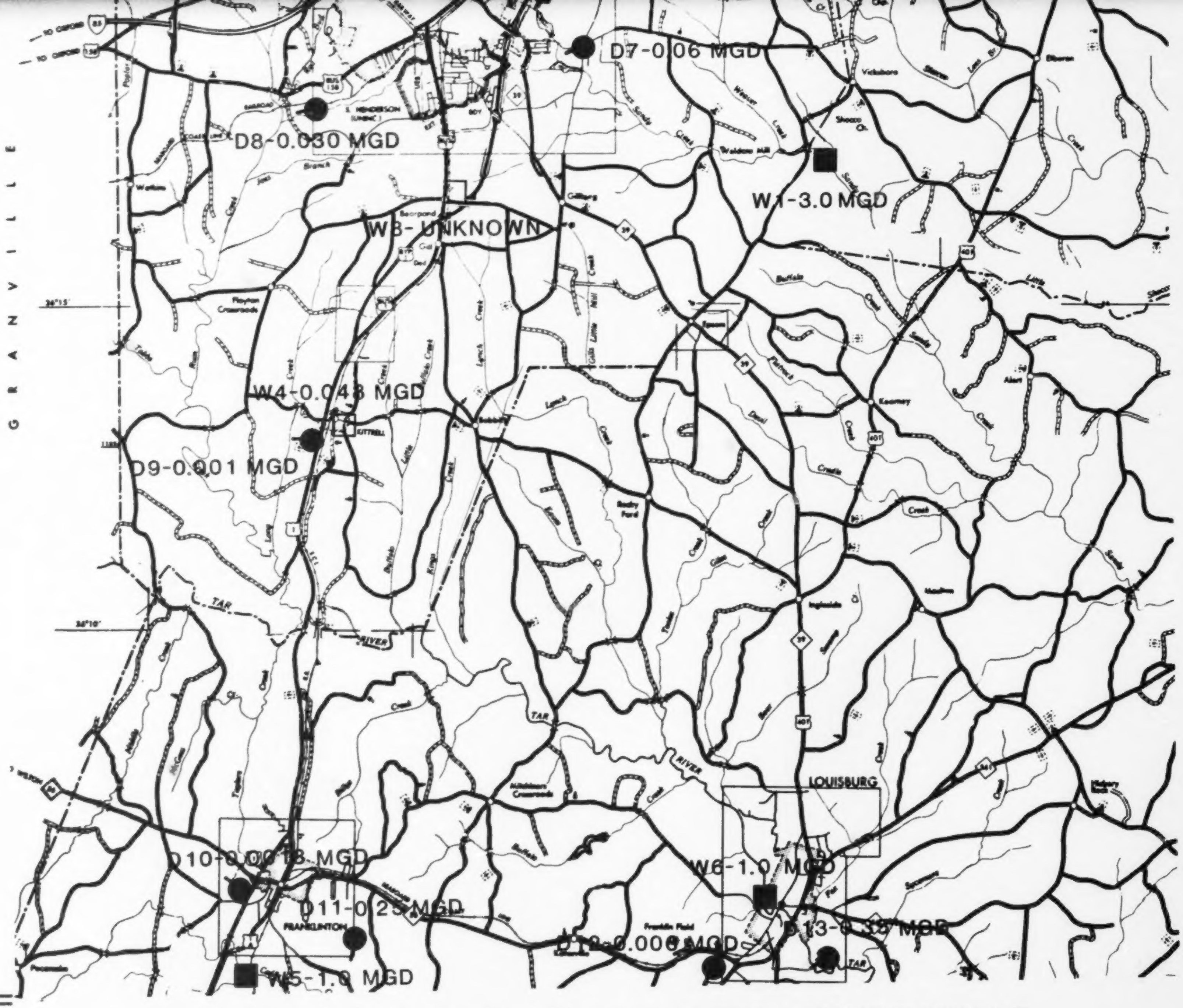

D7-0.06 MGD
D8-0.030 MGD
W1-3.0 MGD
W3-UNKNOWN
W4-0.048 MGD
D9-0.001 MGD
D10-0.0018 MGD
D11-0.25 MGD
W5-1.0 MGD
W6-1.0 MGD
D12-0.006 MGD
D13-0.35 MGD
LOUISBURG
FRANKLINTON
TAR
RIVER
G R A N V I L L E

FIGURE II-12 INDEX MAP OF SITES OF WATER WITHDRAWALS AND POINT-SOURCE DISCHARGES

Bottom Sediments

The bottom sediments of the Tar River and its tributaries are typical various mixtures of gravel, sand, silt, and clay-sized particles of eroded geologic and pedologic material, generally finer with larger stream sizes. These bottom sediments are innocous and support normal sedimentary fauna and flora. The bottom sediments are subject to severe scouring during flood events, particularly in the upper reaches of tributaries.

In the Nutbush Creek area of Kerr Reservoir, the bottom sediments in the center of the channel tend to be silty clay. On the borders of the embayment the sediments have significantly more sand, being sandy silt to silty sand. Center-channel sediments tend to be more clayey, at the expense of silt, in a downstream direction. The carbon content is greater at the upper end where a substantial pollutant load from the Henderson vicinity enters the reservoir. In Nutbush Creek itself, sludge banks of sewage solids have built up for a considerable distance downstream of the Nutbush Creek plant. The bottom sediments here are anoxic and support very little, if any, aquatic flora and fauna.

(2) Water Quantity

The study area is located in the upper reaches of watersheds in igneous-metamorphic rock terrain. Therefore, only relatively small quantities of flowing surface water and ground water are present despite the abundant precipitation. Water must be stored for those uses requiring large volumes or withdrawal rates of water. The principal water storage area, of course, is John Kerr Reservoir, although private lakes are numerous, widespread, and locally important water retention areas.

Surface Water

Only two stream gaging stations are continuously operated on streams within or near the area of investigation. Both of these are on the Tar River, one near the town of Tar River, just west of the map area, and the other at Louisburg. The Louisburg gage has been at its present position for only a few years and is not yet statistically reliable; its predecessor began operation in 1963 but recorded periods of median and high flows only.

The long-term records of the Tar River near Tar River, North Carolina, were analyzed by standard hydrological statistical techniques. The estimated flood flows and low flows for this point are tabulated in Table II-5. Of most importance to the assessment are the quite small low flows despite the size of the drainage basin due chiefly to upstream diversions for water supplies. For comparison, the estimated 7-day, 10-year low flow (i.e., the flow time averaged over a 7-day period that has a 0.1 probability of occurring in any single year) at Louisburg, based on periodic measurements, is 17 cfs.

TABLE II-5
Flow Frequencies of Tar River
Near Tar River, N.C.

FLOOD FREQUENCY

Mean Annual Flood: 4200 cfs
5 - Year Flood: 5600 cfs
10 - Year Flood: 6900 cfs
25 - Year Flood: 9800 cfs
50 - Year Flood: 12500 cfs

LOW-FLOW FREQUENCY

1 - day, 10 year low flow: 0.14 cfs = 0.090 MGD
7 - day, 2 year low flow: 2.5 cfs = 1.62 MGD
7 - day, 10 year low flow: 0.17 cfs = 0.11 MGD
7 - day, 20 year low flow: 0.15 cfs = 0.10 MGD

Median Daily Flow: 48 cfs
Daily Flow Exceeded 90% of the time: 5.2 cfs
Daily Flow Exceeded 5% of the time: 680 cfs

At all other, ungaged points on streams of the study area, indirect techniques must be used to ascertain streamflow characteristics. For flood flows, regionalized multiple linear regression techniques with basin and climatological characteristics as independent variables have been used. For low flows, direct transposition of low flow data from selected similar basins has been utilized based on drainage area alone. This technique provides only a very approximate estimate, and analytical results based on low flows must be interpreted cautiously. There is not an accurate method for transposition or regionalization of low flows.

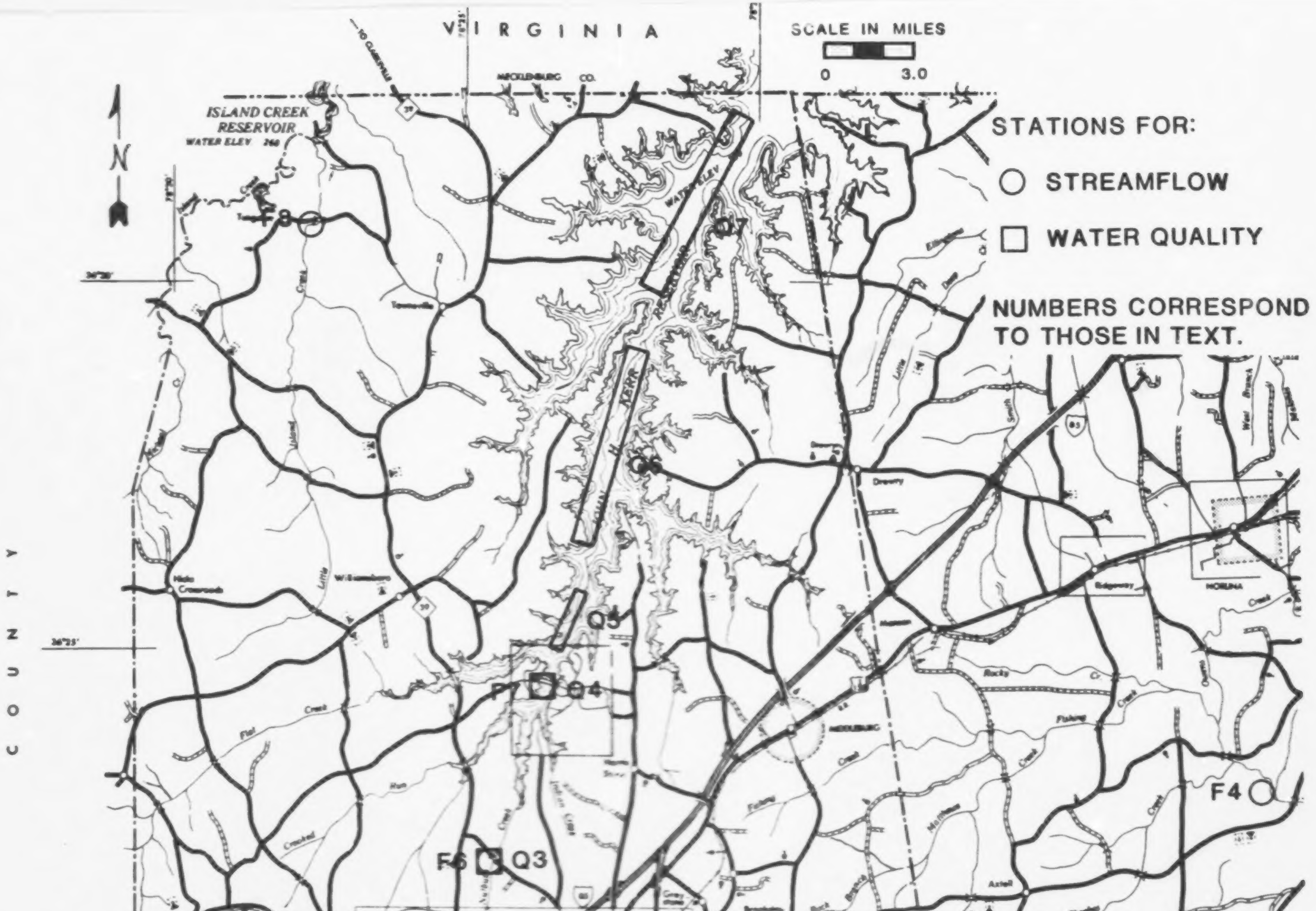
The results of these streamflow analyses at selected points of interest in the study area (Figure II-13) are summarized in Table II-6. The Tar River has anomalously low flows in comparison to other much smaller streams, which reduces the assimilative capacity significantly.

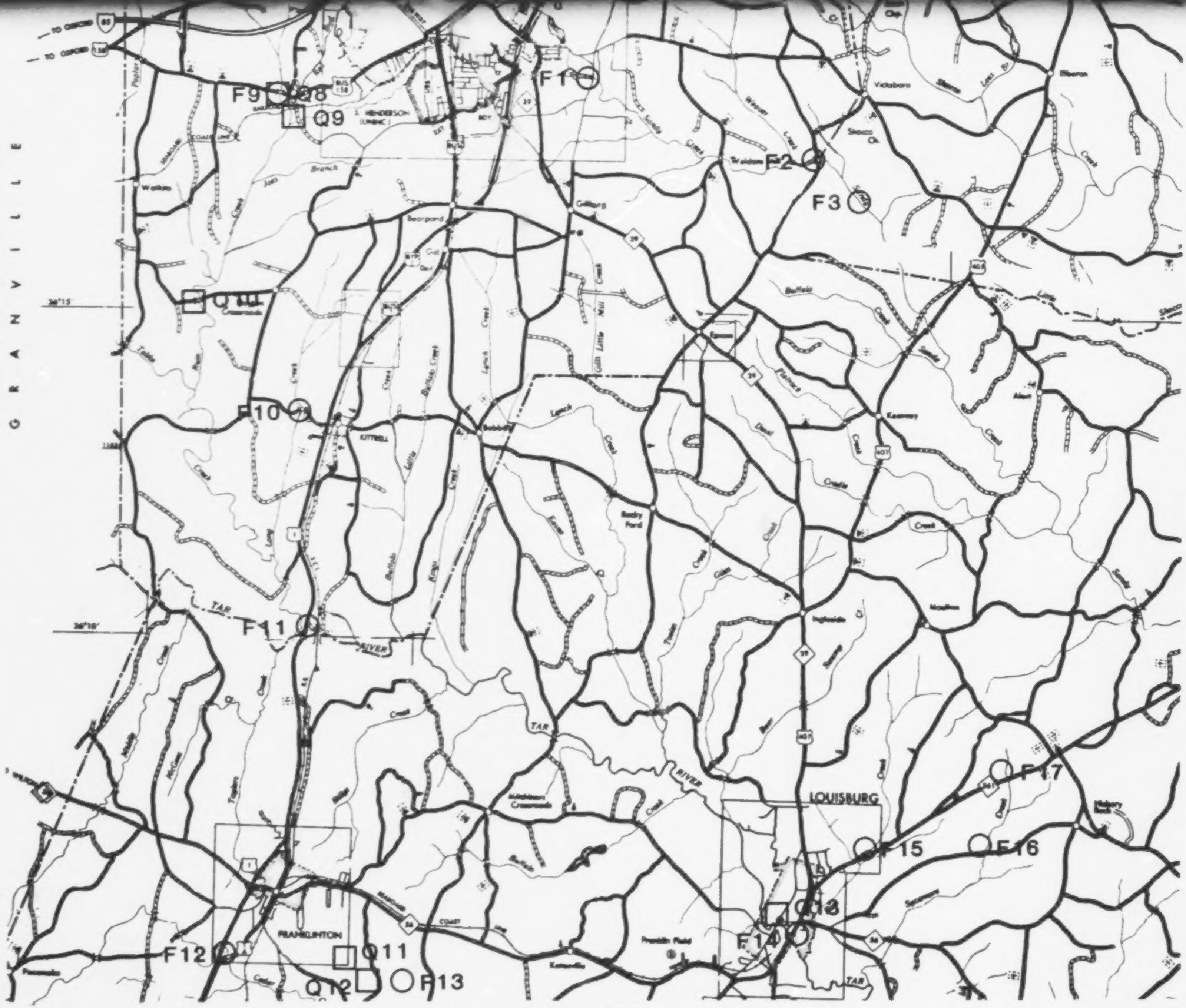
TABLE II-6

HYDROLOGIC CHARACTERISTICS OF SELECTED STREAMS IN THE STUDY AREA

STATION LOCATION	DRAINAGE AREA (mi^2)	AVERAGE FLOW (cfs)*	25-YEAR FLOOD (cfs)	50-YEAR FLOOD (cfs)	7-DAY 10-YEAR LOW FLOW (cfs)*	REMARKS
F1 Sandy Creek at SR 1519	8.3	10	1,630	2,320	0.8	
F2 Sandy Creek at Southerlands Pond	34	31	4,010	5,710	2.3	
F6 Nutbush Creek at Spring Valley Road	3.9	4.9	1,000	1,430	0.04	
F9 Ruin Creek at US 158 Business	7.9	8.5	1,580	2,240	0.065	
F10 Long Branch at Kittrell	7.5	8.2	1,520	2,170	0.16	
F11 Tar River at US 1	330	367	17,200	24,500	1.75	
F13 Cedar Creek SE of Franklinton	30.8	34	3,760	5,360	3.75	
F14 Tar River at Louisburg	429	455	21,100	28,900	17	Corps of Engineers estimates 100-year flood is 21,000 cfs
F15 Fox (Swamp) Creek at NC 56	9.8	9.6	1,810	2,580	0.53	

*Estimate by U.S. Geological Survey, Water Resources Division


VIRGINIA
SCALE IN MILES
0
3.0
STATIONS FOR:
STREAMFLOW
WATER QUALITY
NUMBERS CORRESPOND TO THOSE IN TEXT.
ISLAND CREEK RESERVOIR
WATER ELEV 260
N
MECKLENBURG CO.
TO CLARKSVILLE
COUNTY
KERR
Q7
Q6
Q5
F7
Q4
F6
Q3
F5
Q2
Q1
HENDERSON
N. HENDERSON
S. HENDERSON
F1
F4
F9
Q8
Q9
Townsville
Williamsboro
Drewry
Middleburg
Ridgeway
NORLINA
TO OXFORD
TO OXFORD
36°25'
36°20'



TO OXFORD
GRANVILLE
F1
F2
F3
F9
Q8
Q9
HENDERSON
Q10
Crossroads
Vicksboro
Gillburg
Bearpond
Epsom
Kearney
KITTRELL
F10
Bobbitt
Ingleside
F11
TAR
RIVER
LOUISBURG
F17
F15
F16
13
F14
FRANKLINTON
F12
Q11
Q12
F13
Franklin Field
36°15'
36°10'

FIGURE II-13

INDEX MAP OF LOCATIONS OF SITES WITH AVAILABLE HYDROLOGIC INFORMATION

Ground Water

As mentioned previously, there are two primary types of ground-water reservoirs in the area, the fractured bedrock and the overlying residuum, which are hydrologically connected to form essentially one aquifer system. For purposes of characterization, however, the reservoirs are discussed separately, owing to their different character and the commonly drawn distinction between them in local ground-water use.

The deeply weathered residual material that blankets much of the area is able to transmit water to varying degrees and is widely used only as a domestic water supply. For some areas this saprolite is more than 100 feet thick, but usually it is less than 50 feet. The thickest accumulations are generally on uplands and gentle slopes on fractured metamorphic rocks rather than intrusive igneous rocks such as granite.

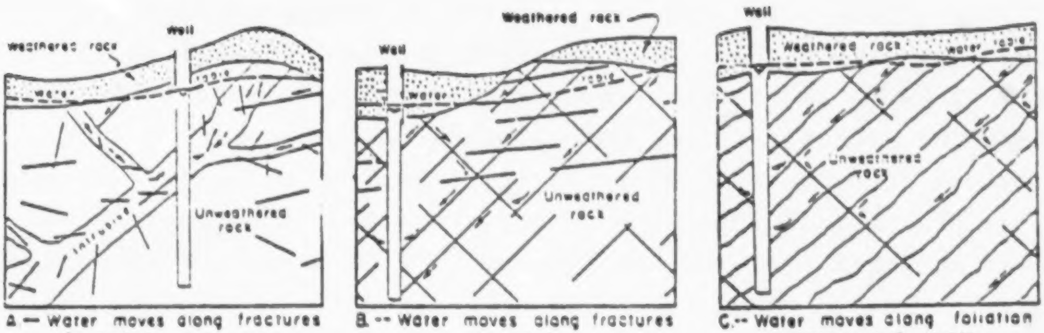
Saprolite is quite porous, and very large volumes of water may be contained in storage. The permeability ranges widely but is usually low, so that only small amounts of ground water, from one to ten gallons per minute, may be developed in an excavated (dug or bored) well. On the other hand, wells in these surficial deposits generally are predictable in their performance. Dug wells with very large storage capacities are often used for the small amounts of water required for domestic purposes.

In addition to serving as a ground-water reservoir, the saprolite also serves as a source bed for recharging the underlying bedrock aquifers. Recharge rates have not been determined. The buffer provided by the saprolite should produce slow, continuous recharge.

Adequate domestic supplies are obtained from drilled wells in bedrock at most locations, and small municipal and industrial supplies may be obtained from wells located where conditions are favorable. An average well yield is 15 gpm. Kittrell (population 430) in Vance County and Norlina (population 930) in Warren County are the only municipalities in the area under investigation that use ground water as a public supply; three wells in granite support an average consumption of 50,000 gallons per day at Norlina and two unusually productive (200 gpm each) wells in mica gneiss are used at Kittrell. Only a few industries use or have used ground water; they include Vance Trucking Company, just south of Henderson; Coca-Cola Bottling Company in Henderson; and Tungsten Mining Company near Townsville, in northwestern Vance County. Ground water is used at various locations for commercial establishments, churches, and schools.

In addition to wells, a number of springs issuing from bedrock are used as water supplies, chiefly for domestic purposes. Of particular note is a relatively large (38 gpm), nearly constant discharge spring in granite southeast of Henderson that is used as the sole water supply for a county correction unit of the state prison system.

The permeability of these bedrock aquifers derives from secondary fractures, joints, foliation, and fractured veins of quartz. In general, most of this secondary permeability is found in the upper few hundred feet. Here water movement is facilitated by larger and more abundant openings caused by weathering and smaller overburden weights. Figure II-14 illustrates such movement of ground water along secondary interstices.


Weathered rock
Well
Water
table
Intrusive
Unweathered rock
Weathered rock
Well
Water
table
Unweathered rock
Well
Weathered rock
Water table
Unweathered rock

A — Water moves along fractures formed by intrusion

B.-- Water moves along fractures in rock

C.-- Water moves along foliation planes and joints

FIGURE II-14

DIAGRAMMATIC ILLUSTRATION OF GROUND-WATER
MOVEMENT BY SECONDARY PERMEABILITY

Source: MA-533

Owing to the buffer provided by the saprolite recharge zone, and to the generally slow movement of water through the interstices, ground-water fluctuations in response to increased rainfall usually are somewhat muted and lag the precipitation event commonly by several days to weeks. In the long term, beyond seasonal fluctuations, there has been no significant change in amount of water in storage, denoting that the area is approximately in geohydrologic equilibrium.

On an averaged, normalized basis, well yields depend principally on topographic location, depth of the well, and rock type, in that order. The average yield for all wells in the study area is about 0.13 gpm/foot of well.

Those wells that are located in stream valleys or dry draws have the highest average yield per foot of well (0.16 gpm/ft). This is about twice the yield of wells located on hills, flats, or slopes). Also, such a topographic location has the smallest percentage of wells yielding one gpm or less. Depressed areas are natural locations of ground-water discharge, since water movement from surrounding areas is focused on these areas. Water at shallower depths is in more permeable zones, and the ground-water reservoir is not as physically restricted by the topographic configuration.

As discussed in the previous section, the secondary permeability generally decreases with depth. Those wells in the area ranging in depth from 0 to 100 feet have an average yield of 0.12 gpm per foot of depth, despite the relatively higher proportion of lower-permeability saprolite. Yields at greater depths fall off rapidly to values below the average for all wells. At depths below 150 feet, an average yield is 0.07 gpm per foot of depth.

Owing to slightly different propensities for development of secondary permeability, the type of rock in which the well is located also affects ground water availability. Granite, owing chiefly to the fractured quartz veins associated with it and despite its relative resistance to weathering, has the highest normalized yield of those rocks in the area under investigation, 0.16 gpm per foot of depth; it also has the highest quartz vein. The other rock units are similar in average water yields, except granodiorite which is generally less than the others. Mica gneiss also appears to have a larger proportion of its wells yielding 1 gpm, or less, than the other rock types.

(3) Water Quality

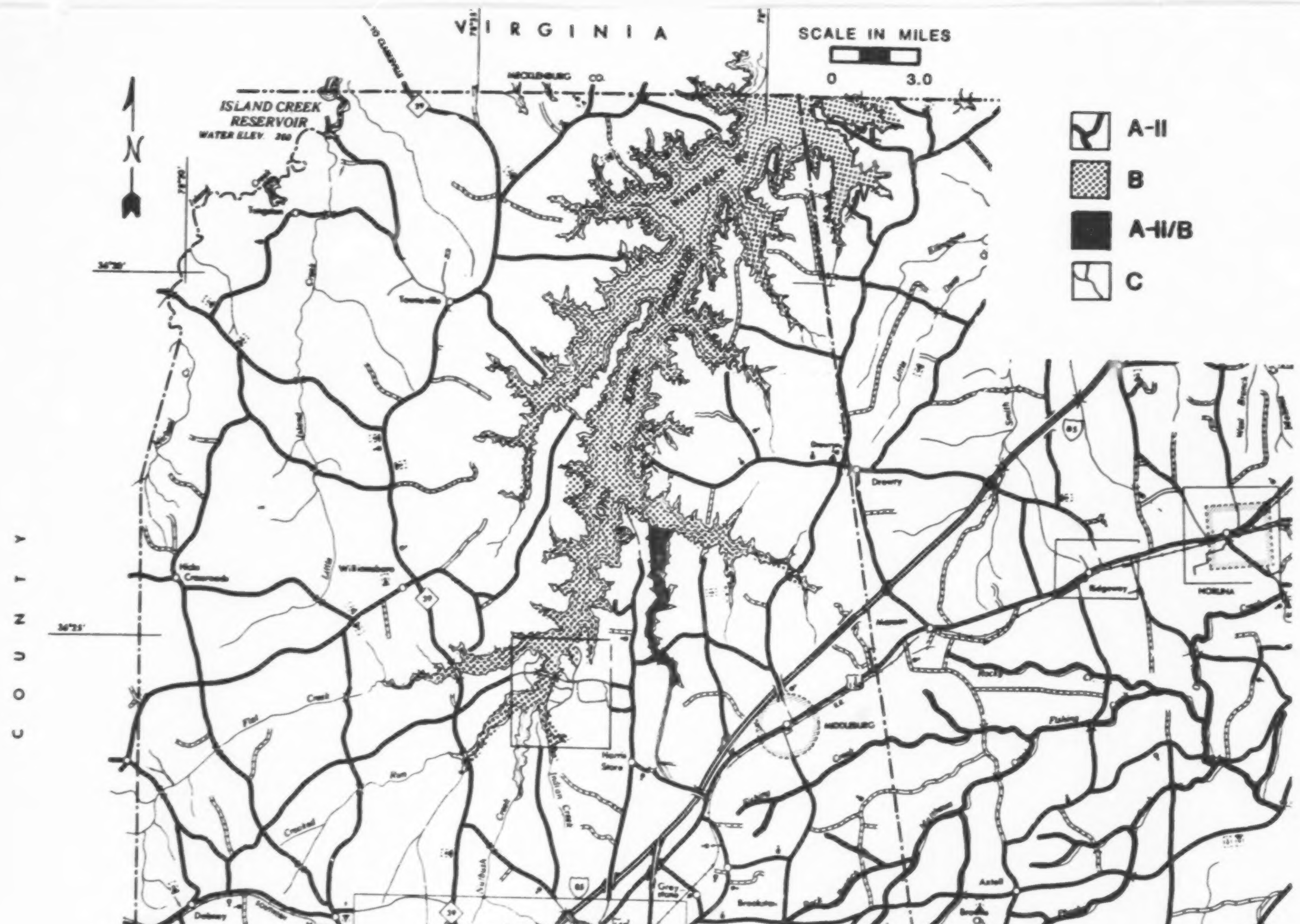
The existing and projected water quality of surface and ground waters in the study area is a central issue in assessing both the need for and the impacts of wastewater treatment facilities. Both natural and man-made sources of pollution degrade water quality in this area currently.

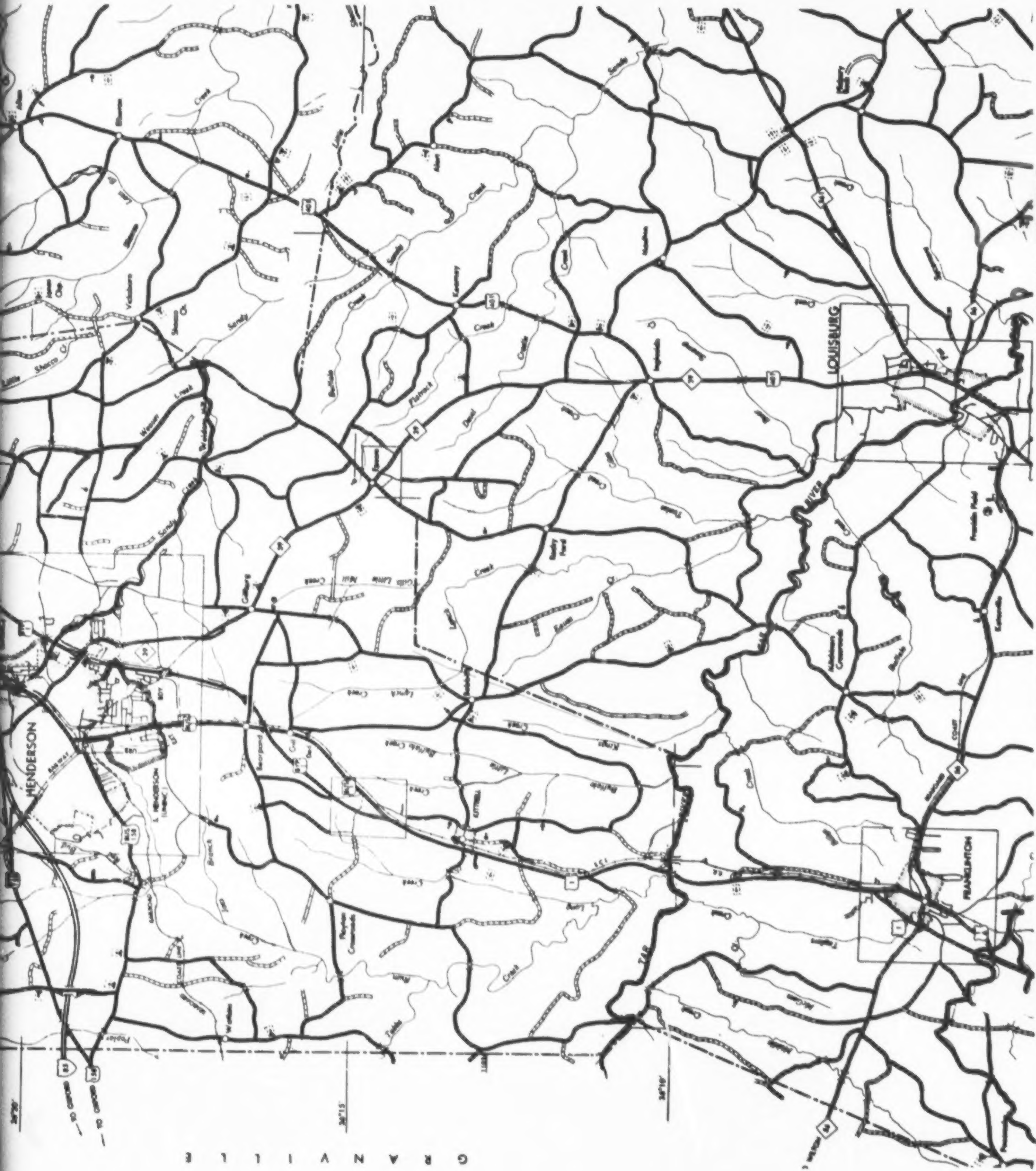
Surface Water

The surface water regime is the primary focus of this assessment. In this subsection, the existing quality of streams and reservoirs is described and areas exhibiting water quality contraventions and the likely sources of this pollution are identified. The water quality classification of surface water bodies in the study area is presented in Figure II-15. The uses of water are directly related to its quality. Water quality is expressed in standards that describe the physical, chemical, and biological characteristics that must be maintained if the water is to be suitable for its intended use. Water quality standards applicable to the water quality classifications shown in Figure II-15 are described in Table II-7.

Stream Quality

The natural water chemistry and quality of streams in the area is, in general, suitable for all uses with little or no treatment. Dissolved solids vary inversely and suspended solids vary directly with stream flows. Locally, however, contraventions of water quality standards have been noted at several monitoring sites, usually those just downstream of point sources of discharge. The potential water quality and the observed water quality are described below for these locations, inasmuch as these streams are possible receiving waters for effluent from the

VIRGINIA
SCALE IN MILES
0
3.0
A-II
B
A-II/B
C
N
ISLAND CREEK RESERVOIR
WATER ELEV. 260
MECKLENBURG CO.
TO CLARKSVILLE
COUNTY
36°30'
36°25'
36°20'
Townsville
Drewry
Manson
Ridgeway
NORLINA
Middleburg
Nutbush
Indian Creek
Flat Creek
Hicks Crossroads
Williamsboro
Gray Rock
Brookston
Cokesbury
Providence Ch.
Vicksboro
HENDERSON
N. HENDERSON
S. HENDERSON
Dabney
TO OXFORD
Little Shocco Cr.
Fishing
Sandy Creek


HENDERSON
LOUISBURG
FRANKLINTON
KITTRELL
RIVER
TAR
G R A N V I L L E

WATER QUALITY CLASSIFICATION OF SURFACE WATERS

FIGURE II-15

TABLE II-7

WATER QUALITY CLASSIFICATION SPECIFICATIONS

1. **Class A-II Waters**

- **General**

Best Usage of Waters: Source of water supply for drinking, culinary or food-processing purposes and any other best usage requiring waters of lower quality.

Conditions Related to Best Usage: The waters, if subjected to approved treatment equal to coagulation, sedimentation, filtration and disinfection with additional treatment if necessary to remove naturally present impurities, will meet the Public Health Service Drinking Water Standards and will be considered safe for drinking, culinary, or food-processing purposes.

- Standards

Items:	Specifications:
Floating solids; settleable solids; sludge deposits	Only such amounts attributable to sewage, industrial wastes or other wastes as will not, after reasonable opportunity for dilution and mixture of same with the receiving waters, make the waters unsafe or unsuitable as a source of water supply for drinking, culinary, or food-processing purposes; injurious to fish and wildlife; or impair the waters for any other best usage established for this class.
Sewage, industrial wastes, or other wastes.	None which are not effectively treated to the satisfaction of the Board and in accordance with the requirements of the State Board of Health.
Odor-producing substances contained in sewage, industrial wastes, or other wastes.	Only such amounts, whether alone or in combination with other substances or wastes, as will not, after reasonable opportunity for dilution and mixture of same with receiving waters, cause taste and odor difficulties in water supplies which cannot be corrected by treatment as specified under "Conditions Related to Best Usage" impair the palatability of fish, or have a deleterious effect upon any best usage established for waters of this class.
Phenolic compounds	Not greater than 0.001 mg/l (phenols).
pH	Shall be normal for the waters of the area, which generally shall range between 6.0 and 8.5, except that swamp waters may have a low of 4.3.
Total hardness	Not greater than 100 parts per million $CaCO_3$.
Dissolved oxygen	Not less than 6.0 mg/l for natural trout waters; 5.0 mg/l for put-and-take trout waters; not less than a daily average of 5.0 mg/l with a minimum of not less than 4.0 mg/l for non-trout waters, except that swamp waters may have lower values if caused by natural conditions.
Sewage, industrial wastes, or other wastes.	**None** which are not effectively treated to the satisfaction of the Board. In determining the degree of treatment required for such wastes when discharged into waters to be used for bathing, the Board will take into consideration the quantity and quality of sewage and wastes involved and the proximity of such discharges to the waters in this class.
Phenolic compounds.	Not to exceed 0.001 mg/l (phenols).
pH.	Shall be normal for the waters in the area, which generally shall range between 6.0 and 8.5, except that swamp waters may have a low of 4.3.
Dissolved oxygen.	Not less than 6.0 mg/l for natural trout waters; 5.0 mg/l for put-and-take trout waters; not less than a daily average of 5.0 mg/l with a minimum of not less than 4.0 mg/l for non-trout waters, except that swamp waters may have lower values if caused by natural conditions.
Toxic waters; oils; deleterious substances; colored or other wastes.	Only such amounts, whether alone or in combination with other substances or wastes as will not render the waters unsafe or unsuitable for bathing, injurious to fish and wildlife, or adversely affect the platability of same, or impair the waters for any other best usage established for this class.
Organisms of coliform group. (Applicable only during the months of May through September. During other months the coliform organism standard for Class "C" Waters shall apply.)	Fecal coliforms not to exceed a log mean of 200/100 ml (either MPN or MF count) based on at least five consecutive samples examined during any 30-day period and not to exceed 400/100 ml in more than 20% of the samples examined during such period. (Not applicable during or immediately following periods of rainfall.)
Temperature.	Not to exceed 5 degrees F. above the natural water temperature, and in no case to exceed 84 degrees F. for Mountain and upper Piedmont waters and 90 degrees F. for lower Piedmont and Coastal Plain waters. The temperature of natural trout waters shall not be significantly increased due to the discharge of heated liquids and shall not exceed 68 degrees F.; however, the temperature of put-and-take trout waters may be increased by as much as 3 degrees F., but the maximum may not exceed 70 degrees F.

TABLE II-7 (Cont.)

WATER QUALITY CLASSIFICATION SPECIFICATIONS

Toxic wastes; oils; deleterious substances; colored or other wastes.	Only such amounts, whether alone or in combination with other substances or wastes as will not render the waters unsafe or unsuitable as a source of water supply for drinking, culinary, or food-processing purposes, injurious to fish and wildlife, or adversely affect the palatability of same, or impair the waters for any other best usage established for this class.
Organisms of coliform group.	Not to exceed 5,000/100 ml as a monthly average (either MPN or MF count); not exceed this number in more than 20% of the samples examined during any one month; nor exceed 20,000/100 ml in more than 5% of such samples. Fecal coliforms (MPN or MF count) not to exceed a log mean of 1,000/100 ml. based on at least five consecutive samples examined during any 30-day period; not exceed 2,000/100 in more than 20% of the samples examined during same period. (Not applicable during or immediately following period of rainfall.)
Temperature.	Not to exceed 5 degrees F. above the natural water temperature, and in no case to exceed 84 degrees F. for Mountain and upper Piedmont waters and 90 degrees F. for lower Piedmont and Coastal Plain waters. The temperature of natural trout waters shall not be significantly increased due to the discharge of heated liquids and shall not exceed 68 degrees F.; however the temperature of put-and-take trout waters may be increased by as much as 3 degrees F. but the maximum may not exceed 70 degrees F.
Radioactive substances.	Gross beta activity (in the known absence of Strontium 90 and alpha emitters) not to exceed 1,000 picocuries per liter.

2. Class B Waters

- General

Best Usage of Waters: Bathing and any other best usage except as source of water supply for drinking, culinary, or food-processing purposes.

Conditions Related to Best Usage: The waters, under proper sanitary supervision by the controlling health authorities, will meet accepted standards of water quality for outdoor bathing places and will be considered safe and satisfactory for bathing purposes. Also, suitable for other uses requiring waters of lower quality.

3. Class C Waters

- General

Best Usage of Waters: Fishing, boating, wading and any other usage except for bathing or as a source of water supply for drinking, culinary, or food-processing purposes.

Conditions Related to Best Usage: The waters will be suitable for fish and wildlife propagation. Also, suitable for boating, wading, and other uses requiring waters of lower quality.

- Standards

Items:	Specifications:
Floating solids; settleable solids, sludge deposits.	Only such amounts attributable to sewage, industrial wastes or other wastes as will not, after reasonable opportunity for dilution and mixture of same with the receiving waters, make the waters unsafe or unsuitable for bathing, injurious to fish and wildlife, or impair the waters for any other best usage for this class.
pH.	Shall be normal for the waters in the area, which generally shall range between 6.0 and 8.5, except that swamp waters may have a low of 4.3.
Dissolved oxygen.	Not less than 6.0 mg/l for natural trout waters; 5.0 mg/l for put-and-take trout waters; not less than a daily average of 5.0 mg/l with a minimum of not less than 4.0 mg/l for non-trout waters, except that swamp waters may have lower values if caused by natural conditions.
Toxic waters; oils; deleterious substances; colored or other wastes.	Only such amounts, whether alone or in combination with other substances or wastes as will not render the waters unsafe or unsuitable for bathing, injurious to fish and wildlife or adversely affect the platability of same, or impair the waters for any other best usage established for this class.
Organisms of coliform group. (Applicable only during the months of May through September. During other months the coliform organism standard for Class "C" Waters shall apply.)	Fecal coliforms not to exceed a log mean of 200/100 ml (either MPN or MF count) based on at least five consecutive samples examined during any 30-day period and not to exceed 400/100 ml in more than 20% of the samples examined during such period. (Not applicable during or immediately following periods of rainfall.)

TABLE II-7 (Cont.)

WATER QUALITY CLASSIFICATION SPECIFICATIONS

- Standards

Items:	Specifications:
Floating solids; settleable solids, sludge deposits.	Only such amounts attributable to sewage, industrial wastes, or other wastes as will not, after reasonable opportunity for dilution and mixture of same with the receiving waters, make the waters unsafe or unsuitable for bathing, injurious to fish and wildlife, or impair the waters for any other best usage for this class.
Temperature.	Not to exceed 5 degrees F. above the natural water temperature, and in no case to exceed 84 degrees F. for Mountain and upper Piedmont waters and 90 degrees F. for lower Piedmont and Coastal Plain waters. The temperature of natural trout waters shall not be significantly increased due to the discharge of heated liquids and shall not exceed 68 degrees F.; however, the temperature of put-and-take trout waters may be increased by as much as 3 degrees F., but the maximum may not exceed 70 degrees F.

Source: FR-171

proposed treatment facility(s) and their performance under stress is of general concern. Reference should be made to the index map in the preceding Figure II-13 for the designations and locations of water quality monitoring stations and to the preceding Figure II-12 for locations of point source discharge.

Nutbush Creek is probably the most polluted stream in the study area, and the water quality implications for Kerr Reservoir downstream are of considerable concern. Stations Q1 and Q2 show severe degradation with respect to dissolved oxygen, pH, and probably fecal coliform. Stations Q1 and Q2 are at points below the discharge of Perfect Packed Pickle (H. J. Heinz) Co., D2, but upstream of D1, the outfall of the Nutbush Creek Sewage Treatment Plant (STP). Station Q3, in a segment classed "C", and Station Q4, on Kerr Lake which is classed "B" at that point, also indicate contravention of criteria; these stations are affected by the combined pickle packing plant effluent and the STP effluent, with the more downstream station having only marginal degradation. The existing effluent from the STP is also malodorous, and local citizens' reports suggest it may be detected often as far downstream as Q3. At this station, recent investigations by the Corps of Engineers have also found Sphaerotilus, a nuisance iron-scavenging bacteria, frequently associated with sewage solids, that produces a malodorous brown slime or sludge along creeks. Nutbush Creek is in very poor condition.

Referring to Figure II-15, Sandy Creek has three separate water quality classifications. From its origin to the County Line Road it is classified A-II; the next stretch to Alert Road receives a "C" classification, and from there downstream, a "B" classification. Very little data are available for Sandy Creek, but generally the stream is of high quality. Because it is the water supply of Henderson (in the fall of

1976 it became a supplementary supply), the upper reaches are classified A-II; this quality water is maintained in Sandy Creek over the entire study area, but the different classifications are based on known and physically suitable use, as opposed to instream quality. Sandy Creek is not monitored well enough to characterize any existing variations in water quality. The City of Henderson discharges filter backwash water weekly to Sandy Creek at its water treatment plant site. Occasional bypasses of sewage from pumping stations may also have occurred.

Ruin, Red Bud, and Tabbs Creeks are somewhat turbid but of general good quality. Some marginal conditions of pH and coliform have been noted in upper Ruin and Red Bud Creek and are ascribed to urban and suburban land runoff. Data from Station Q10, below the discharge of the Oxford Road ("Red Bud Creek") STP, and an intensive survey of Ruin Creek indicate that no significant receiving-stream problems have developed. This plant is presently hydraulically overloaded which impairs effluent quality. Due to the lack of dilution water, dissolved oxygen is low over a rather short segment several thousand feet downstream of the STP outfall.

The Tar River, an A-II stream throughout the area under investigation, is the water supply for Louisburg. The stream generally is of good quality, but near Louisburg its lower flows may be degraded somewhat by runoff. The only significant discharge that enters the Tar in the study area is that of the Town of Franklinton Water Treatment Plant (D10) which discharges untreated filter backwash water, with high suspended solids content, into Taylor's Creek tributary of the Tar River. The Franklinton STP discharges a very poor quality effluent (D11) to the Cedar Creek tributary of the Tar River, which has resulted in severe degradation of the smaller stream; Cedar Creek enters the Tar south of Louisburg, just south of the study area.

Reservoir Quality

Owing to its many, varied uses, including public water supply (1976) and water-contact recreation, the Nutbush arm of John Kerr Reservoir must be thoroughly characterized as to existing water quality conditions for the environmental assessment. In particular, its status as a receiving body must be evaluated in terms of the "B" water quality standard in most of this portion of the reservoir, and the "A-II/B" standard in the Anderson Swamp Creek finger.

The Nutbush arm currently has good overall water quality, but this condition apparently prevails in spite of, rather than owing to, existing discharges and limnological characteristics. The uppermost reach of the Nutbush arm has been water quality classified as "C." Several detailed investigations have been and are being conducted to better define problem areas and water quality management. Preliminary interpretations of existing data suggest that the combination of very long hydraulic retention time, poor water circulation, the high shoreline length-to-water volume ratio, and especially the poor quality effluents that enter at the upper end of this arm of the lake has produced an essentially eutrophic condition throughout, but especially in the upper portions. The Nutbush arm has recently experienced nuisance conditions with respect to aquatic biological growth. These problems may be difficult to remedy, at least in the short term. If permitted to continue, the problems may add substantially to the cost of treating water at the new regional water treatment facility, since nuisance aquatic organisms can cause taste and odor problems which are difficult and expensive to remove.

The results of the most recent (1974-1975) comprehensive survey of water quality in Nutbush Creek arm of the reservoir (WE-222) indicate that annual nutrient loadings in this arm are about 22,000 lbs. of total nitrogen and 68,000 lbs. of total phosphorus. The component parts of these loadings are not comparable with those reported by the 1973 National Eutrophication Survey (NES) of Kerr Reservoir owing to the different accounting of non-point sources and direct precipitation. The more recent 1974-1975 survey is probably more accurate, as it is based on more data, demonstrates a mass balance for conservative parameters, and does not use national averages as does the NES. Point sources in the Nutbush arm account for about one-half of the nitrogen loading and two-thirds of the phosphorus loading, according to the 1974-1975 survey.

Phosphorus is probably the usual biological growth-limiting nutrient. Over 97 percent of the variation in chlorophyll a production in the Nutbush arm during stratified conditions is accounted for by variation in the phosphorus loadings (WE-222). However, the nitrogen-to-phosphorus ratios in the Nutbush arm are much lower than in the rest of Kerr Reservoir, and the ratio is generally lowest in the uppermost reaches. This relation is due to the high nitrogen loading from Nutbush Creek and to the fact that phosphorus is evidently increasingly removed by adsorption onto suspended and bottom sediments in a downstream direction. While phosphorus is limiting in the more "down-lake" portions of Nutbush arm, nitrogen-limiting conditions may obtain in the uppermost reaches (above Q4), where the biological growth potential is highest due to the high nutrient loadings (WE-222). In this area, however, neither nutrient is a growth-limiting factor since high concentrations of each nutrient are available to aquatic flora.

Phosphorus is the constituent of most interest regarding the condition of the Nutbush arm because two-thirds of the total phosphorus loading to the lake is from point sources for which control technologies exist. Using the Vollenwieder phosphorus loading boundary concept with areally averaged loadings, from mean depths and retention times given in WE-222, any phosphorus loading greater than about 0.2 grams P (total)/meter^2 is unacceptable with respect to the enrichment process. Additional nuisance conditions could be expected to occur at loadings greater than this figure. This loading is several times lower than values for Kerr Reservoir as a whole, the difference reflecting chiefly the much longer hydraulic retention in the Nutbush arm. The existing phosphorus loading for Nutbush arm, from the data given above, is equivalent to about 0.6 grams P/m^2/year.

Eutrophication also has implications for pH in the reservoir. Values of pH in the Nutbush arm have occasionally exceeded recommended limits for contact recreation (8.5 standard units) and for protection and propagation of game fish (9.0 standard units). These high-pH episodes are generally accompanied by supersaturated dissolved oxygen and higher nutrient levels, indicative of increased photosynthetic activity. Presumably, excessive algal growth and concomitant contraventions of water quality standards for pH could be decreased or avoided by decreasing the nutrient loadings, particularly phosphorus.

In addition to water quality problems related to eutrophication, the uppermost reaches of the Nutbush arm of the lake (above Station Q4) occasionally have experienced very high fecal coliform counts that constitute a health hazard. These pollution episodes, which are accompanied by distinct untreated sewage odor and color, are probably related to local septic tank problems in the immediate drainage area or to upset conditions at the upstream municipal treatment plant. Fecal coliform counts increase dramatically in the backwater areas of the reservoir to concentrations above the abnormally high levels in Nutbush Creek. In absence of other information, this condition suggests very poor advection in this area.

At more downstream stations on the arm (05-07), no fecal coliform problems generally exist, although elevated concentrations of coliform and nutrients have been reported following heavy rains.

The thermal stratification has a marked but predictable effect on water quality. Generally speaking, this stratification effect includes lower overall values of dissolved oxygen, organic (Kjeldahl minus ammonia) nitrogen, phosphorus, and surface color, and higher overall values for temperature and turbidity. The hypolimnion, the layer of water below the transition depth, tends to have much lower dissolved oxygen levels and temperatures and higher ammonia, total nitrogen, total phosphorus, and turbidity levels than the overlying epilimnion. Other investigations have demonstrated that hypolimnetic dissolved oxygen is often depleted, especially in water adjacent to the lake bottom sediments. These water quality variations are a normal consequence of the thermal stratification, or compartmentalization, which restricts circulation and induces recycling of nutrients and exhaustion of limited dissolved oxygen supplies.

The only point-source discharges to the Nutbush arm are those (D1 and D2) that discharge to Nutbush Creek upstream of the reservoir; no point-source discharges are made directly to the lake.

Non-Point Sources of Pollutants

From the preceding discussion on reservoir quality, it may be inferred that non-point sources of pollutants also significantly affect water quality, in that only part of the pollutant loadings are attributable to point source discharges. Non-point sources affect stream water quality as well as reservoir quality.

Agricultural runoff and sediment-laden runoff are by far the most significant non-point sources of pollutants, yet virtually no data exist to quantify their contributions. There is an important interaction between these in that suspended solids may be the principal transport mechanism for biodegradable organic matter, other organics, and nutrients derived from agricultural land. Moreover, sediment is not only a water pollutant *per se*, but also represents erosion of valuable or potentially valuable land. Sediment loss in the study area is estimated to be on the order of one ton per acre per year. The rate differs greatly with land use, with wood products extraction and agriculture as primary sources of local siltation. Agricultural runoff also includes pollution from fertilizers, pesticides, herbicides, and animal wastes. It is estimated that ten to twenty percent of the several tens of thousands of pounds of fertilizer, pesticides, and herbicides used annually is transported to surface streams.

Another non-point source that is probably locally significant, arises in areas where septic tanks are heavily used. In such areas, septic tank effluent eventually reaches surface water bodies after biological degradation of organic matter and die-off of coliform bacteria. Nevertheless, the effluent will contain a residual of nutrients, particularly nitrogen which is not removed in the soil; the approximate loadings are about 9.4 pounds nitrogen per capita per year and 0.25 pounds phosphorus per capita per year.

It seems likely, but is not corroborated, that urban runoff from Henderson, Franklinton, and Louisburg locally affects area water quality. High fecal coliform counts which occur in proximity of these municipalities particularly after heavy rains are probably attributable to urban runoff.

Ground Water

The overall water quality of ground water in the area is very good and is suitable for most domestic, municipal, and industrial uses, usually without treatment. The water is of the calcium and sodium bicarbonate type and may be soft or hard, but ground water in the principal units (granite and mica gneiss) is usually soft. Iron content is usually low but locally may be a limitation on use, particularly in the mica gneiss and mica schist units. The metavolcanic sequence is of more variable quality than other units; in particular, the water may have excessive hardness and iron content and may also be corrosive at some locations. Generally speaking, however, the chemical character of ground water shows little relation to the rock units.

No specific areas of existing ground water pollution have been identified in the area. At the present time, the largest threats to ground-water quality are considered to be operation of septic tanks in unfavorable areas, unsecure and sanitary landfills, and infiltration of fertilizers and herbicides/pesticides from agricultural land. Areas of concentrated septic tank use, such as that in the Henderson vicinity, may be particularly susceptible to ground-water contamination.

d. Land/Water Interface

The creeks and rivers of the study area are aligned roughly parallel to the generally northeast structural grain, with only the larger streams, notably Tar River and Sandy Creek, transverse to the grain (Figure II-3). Numerous small impoundments near the head waters of secondary tributaries are used to obtain and store water for agricultural use at higher elevations than the creeks that drain the area.

The most significant physical aspect of the stream-land interface is flooding. Because the drainage areas are small and the stream valleys are V-shaped, flooding generally occurs only in laterally restricted areas. Flooding is significant in two areas. It occurs in portions of Tabbs and Ruin Creeks, due to their anomalously wide flood plains and on portions of Sandy Creek and the Tar River, due primarily to their low hydraulic gradient and also their large discharge.

The shores and backwater areas of Kerr Reservoir, a variable-level lake, are areally important land-water interfaces. Kerr Reservoir is operated for various uses at various lake level elevations:

Use	Level (feet)
Uncontrolled Flood Storage	320 - 326
Maximum Induced Surcharge	321
Static Full Pool	320
Flood Control	300 - 320
Maximum Power Pool	300
Hydroelectric Power Generation	268 - 300
Design Minimum Power Pool	268

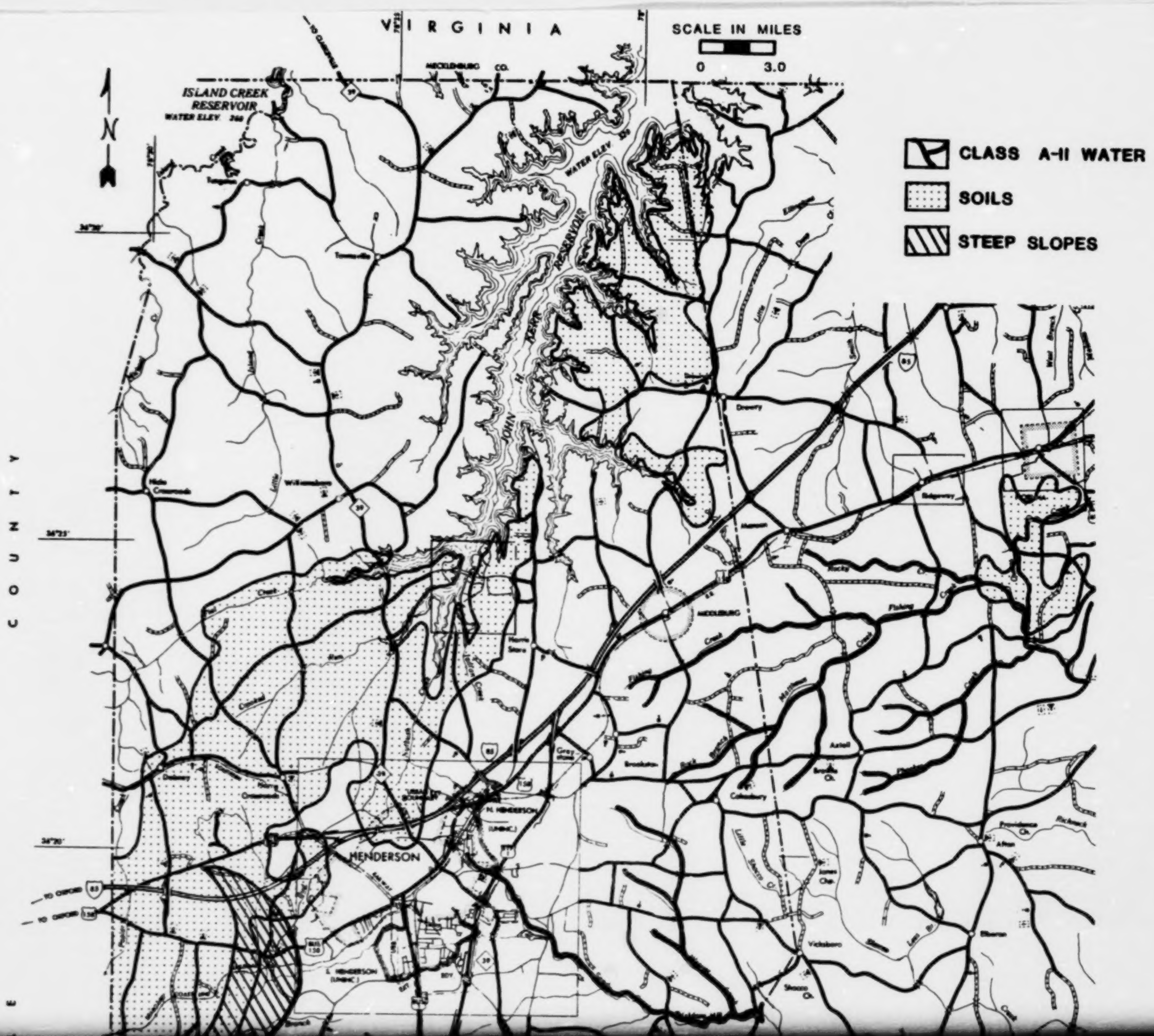
The lake level will normally fluctuate by several feet above and below the maximum power pool. Specific features of reservoir regulation include: a reasonably steady reservoir level for three or four weeks about mid-April to insure success of black bass spawning; a rapid drawdown of one to two feet surcharge above the maximum power pool in the spring to strand drift; to the extent possible, maintenance of reservoir at maximum power pool from April to June to curb invasion by shoreline growth; and to the extent possible, gradually draw down reservoir below maximum power pool from July through September at a rate of 0.2 feet per week or more, in order to keep shoreline below advancing growth for mosquito control. These aspects are subordinate to other flow regulation requirements for power generation and especially flood control.

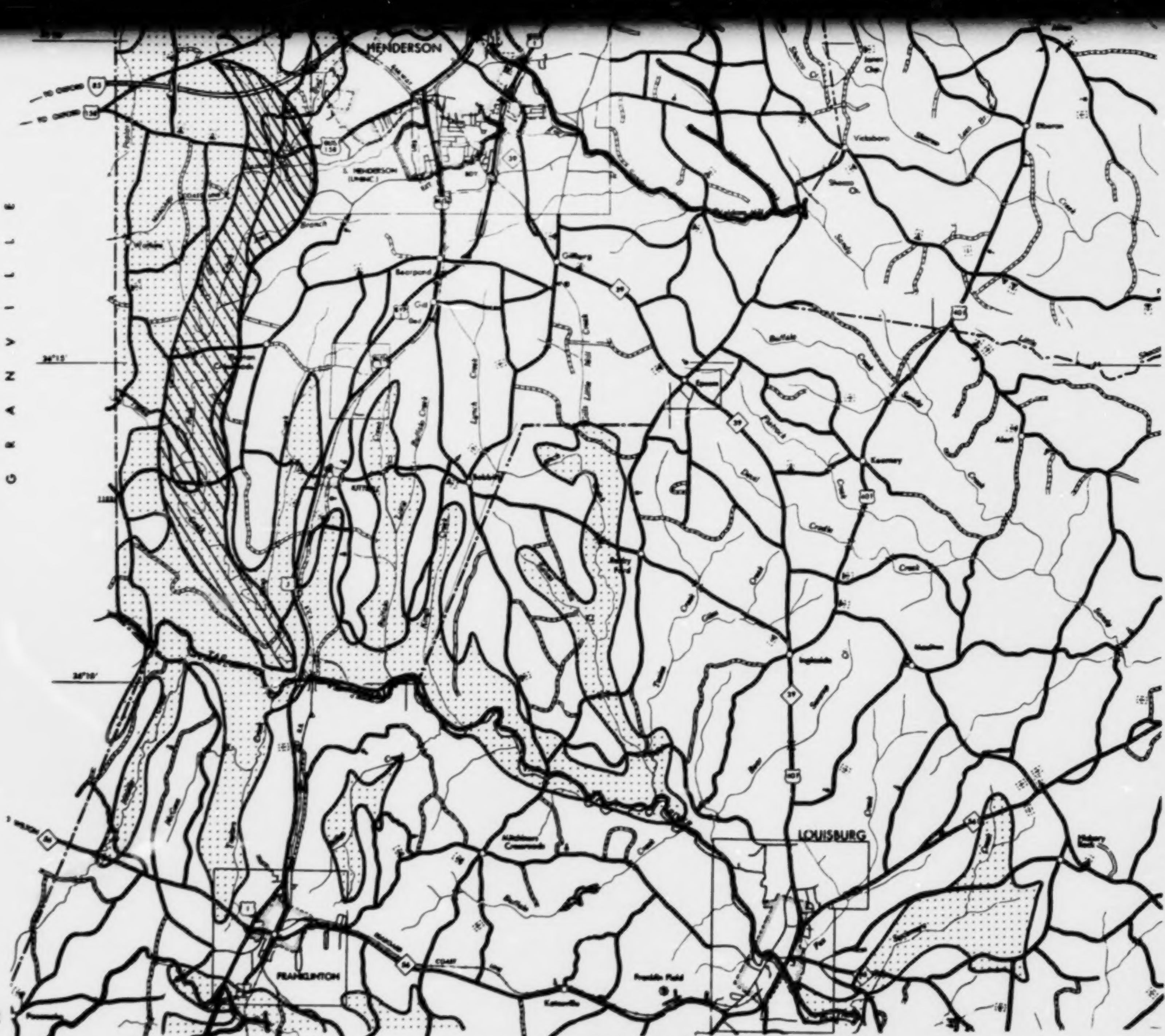
e. Sensitive Areas

Sensitive natural areas are geographic areas which may be more susceptible to damage from the implementation of the project than other areas. Some of these areas are very generalized such as surface waters, floodplains, and groundwater recharge areas. Others are quite localized and cover only a small, specific portion of the study area. They include the flood retention areas, steeper slopes (greater than 25 percent), unique forests and woodlands, habitats of rare or endangered species, and sensitive geologic areas.

Some of these types of sensitive areas are shown in Figure II-16. These are the surface waters used as water supplies, areas of steep slopes, and soils that are easily erodible or have high shrink-swell potential. Other sensitive areas are very local in extent and no advantage is gained from a graphic display. However, by referring to the surface water map, the topographic map, and the soils map, most of the other sensitive areas can be located approximately.

The floodplains of the creeks in the study area are very narrow. They extend only a few tens of feet to a few hundred feet on both sides of most creeks. The Wehadkee silt loam and Congaree silt loam are the characteristic soils of these areas.


VIRGINIA
SCALE IN MILES
0
3.0
MECKLENBURG CO.
ISLAND CREEK RESERVOIR
WATER ELEV. 266
JOHN H. KERR RESERVOIR
WATER ELEV.
CLASS A-II WATER
SOILS
STEEP SLOPES
COUNTY
HENDERSON
N. HENDERSON
MIDDLEBURG
Drewry
Ridgeway
Manson
Townsville
Williamsboro
Nutbush Crossroads
Brookston
Gray Rock
Cokesbury
Kittrell
Vicksboro
Epsom
Bearpond
Dabney
Rock Spring Crossroads
Rocky Cr.
Fishing Creek
Sandy Cr.
Little Sandy Cr.
Little Shocco Cr.
Shocco Cr.
Flat Cr.
Providence Ch.
Afton
Eberon
Nutbush Cr.
TO OXFORD
TO OXFORD
TO CLARKSVILLE
85
158
39
1
36°30'
36°25'
36°20'


HENDERSON
S. HENDERSON
GRANVILLE
Gillburg
Kearney
Epsom
Ingleside
Pilot
Vicksboro
Kittrell
Bobbitt
LOUISBURG
FRANKLINTON
Franklin Field
Youngsville
Royal
Cedar Creek
Sandy Creek
Cypress Creek
Lynch Creek
Tar River
TO OXFORD
TO OXFORD
36°15'
36°10'

NATURAL SENSITIVE AREAS
FIGURE II - 16

Any unique forests or woodlands would include selected portions of the river-edge hardwoods, located within the floodplains of Ruin, Tabbs, and Sandy Creeks. Slopes of 25 percent and more occur in a few places at the edges of the floodplains of Ruin Creek, some of its tributaries, and upper Sandy Creek. Besides Kerr Lake, the only flood retention areas are the small ponds and lakes on the major creeks. Since the study area is situated at the headwaters of many small creeks, there is little need for sizeable flood control projects. Due to the thickness of residuum and depth of weathering of the bedrock, most upland areas, especially those with sandy soils, should be considered ground-water recharge areas.

2. Biological Components

a. Overall Study Area

(1) Land

The natural vegetation of the study area is composed of species from four vegetative communities: river-edge hardwoods (ASF* Type 59); loblolly pine hardwoods (ASF Types 69,71); shortleaf pine hardwoods (ASF Type 38); and old fields (HA-421). The forest community types are the climax vegetation of the area. Each of the first three communities is specific to certain types of soil with certain degrees of slope. Because of this specificity, the presence of these three vegetative communities may generally be projected by consulting the detailed soil map prepared for the study area. The old field community is a series of successional stages from agricultural usage to one of the three forest types. Most of the old field community is in the grass- and sedge-dominated stages with only a few used for cattle grazing. Table II-8 lists the major species and soil type and slope for each forest community type and Figure II-23 displays forested areas. A comprehensive list of fauna in the entire study area appears in the Technical Reference Document (RA-R-276).

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*American Society of Foresters

The dominant species in the climax vegetation of the Piedmont region are the hardwood trees; however, due to the various disturbances, the climax has been upset. The major disturbing factors during the past several hundred years have been agriculture, logging, and fires. These factors have promoted species other than those in the climax forests. Fires set by nature and the Indians before the arrival of the white settlers burned the slower growing, less fire-resistant hardwoods, thereby encouraging the pines. The settlers then cut the remaining large hardwoods for use as building material and firewood. They then cut the better types of pine, such as the longleaf. Since it normally takes from one to five hundred years for pine forests to be taken over by oak-hickory hardwoods when they are not disturbed, the constant disturbance since the early settlers has encouraged the faster growing varieties of pine such as loblolly and shortleaf (WE-216). Both of these generally grow on well drained sandy-type soils with the shortleaf being able to prosper in slightly drier areas with steeper slopes.

In the study area, few pure stands of any tree species can be found. Generally there is a mixture of pines and hardwoods with old fields in all of the various successional stages from first-year crabgrass and third-year broomsedge through the even age pine stands to those nearing mixed pine-hardwood forest. On the drier hillsides with steeper slopes, the shortleaf pine-hardwoods predominate. The loblolly pine-hardwoods generally occur on the same types of soils with slightly less slope.

TABLE II-8

Generalized Forest Communities With
Soil Types and Slopes Preferred

GENERALIZED COMMUNITIES		ASF TYPE	SLOPE	SOIL TYPE
RIVER-EDGE HARDWOODS		59		
River birch	Betula nigra		0-8%	Congaree silt loam
Sycamore	Platanus occidentalis			Wehadkee silt loam
Tulip poplar	Liriodendron tulipifera			Appling sandy loam
Black willow	Salix nigra			
Sweet gum	Liquidambar styraciflua			
White ash	Fraxinus americana			
Green ash	Fraxinus pennsylvanica			
Black gum	Nyssa sylvatica			
Red maple	Acer rubrum			
Water oak	Quercus nigra			
Willow oak	Quercus phellos			
Scarlet oak	Quercus coccinea			
Smooth alder	Alnus rugosa			
Honeysuckle	Lonicera sp.			
Greenbriar	Smilax spp.			
Blackberry	Rubus spp.			
Ironwood	Carpinus carolina			
Hackberry	Celtis sp.			
Eastern cottonwood	Populus deltiodes			
Black walnut	Juglans nigra			
SHORTLEAF PINE-HARDWOODS		38		
Shortleaf pine	Pinus echinata		Greater than 15%	Pacolet clay loam
Loblolly pine	Pinus taeda			Pacolet sandy loam
Virginia pine	Pinus virginiana			Cecil clay loam
White oak	Quercus alba			Cecil sandy loam
Northern red oak	Quercus rubra			Wilkes sandy loam
Southern red oak	Quercus falcata			Louisburg coarse sandy loam
Blackjack oak	Quercus marilandica			Wedowee sandy loam
Post oak	Quercus stellata			
Willow oak	Quercus phellos			
Red cedar	Juniperus virginiana			
Mockernut hickory	Carya tomentosa			
Red maple	Acer rubrum			
Sweet gum	Liquidambar styraciflua			
Sourwood	Oxydendrum arboreum			
Dogwood	Cornus florida			
Honeysuckle	Lonicera sp.			
Grapes	Vitis spp.			
Blackberries	Rubus spp.			
Huckleberries	Vaccinium spp.			
Black oak	Quercus velutina			
Scarlet oak	Quercus coccinea			
LOBLOLLY PINE-HARDWOODS		69,71		
Loblolly pine	Pinus taeda		Less than 15%	Pacolet clay loam
Shortleaf pine	Pinus echinata			Pacolet sandy loam
Eastern white pine	Pinus strobus			Cecil clay loam
White oak	Quercus alba			Cecil sandy loam
Red oak	Quercus borealis			Enon fine sandy loam
Southern red oak	Quercus rubra			Vance sandy loam
Blackjack oak	Quercus marilandica			Wilkes sandy loam
Post oak	Quercus stellata			Worsham loam
Black oak	Quercus velutina			Louisburg coarse sandy loam
Water oak	Quercus nigra			Wedowee sandy loam
Pin oak	Quercus palustris			Appling sandy loam
Mockernut hickory	Carya tomentosa			Helena sandy loam
Sweet gum	Liquidambar styraciflua			Durham sandy loam
Tulip poplar	Liriodendron tulipifera			
Dogwood	Cornus florida			
Sourwood	Oxydendrum arboreum			
Red maple	Acer rubrum			
Black locust	Robinia pseudoacaia			
Honeysuckle	Lonicera sp.			
Grapes	Vitis spp.			
Blackberries	Rubus spp.			
Huckleberries	Vaccinium spp.			
Beech	Fagus grandifolia			
Dward sumac	Rhus copallina			
Redbud	Cercis canadensis			

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*American Society of Foresters

River-edge hardwoods dominate the alluvial areas of creek and river bottoms where the slopes are usually less than 5% and the soil moisture is high There are many species of trees and shrubs present in these communities that are not as prominent as the larger trees. They are important to the wildlife of the area since many of them produce fruits, berries and nuts. In addition, most of them form the lower thirty feet of vegetation cover in the more open forests This provides habitat for many wild animals.

In addition to the dominant trees and shrubs listed in Table II-8, hundreds of additional vascular plants are found in the area. These species typically range widely and are found wherever their special habitat requirements are met.

The study area has a very diverse fauna with not only a large number of resident species but also a large number of migratory species. Since most terrestrial animals are mobile, they can be expected to choose the habitat that most nearly corresponds to their various requirements. Many move from one area to another during the course of the day, feeding in one, resting in another, and sleeping in still another. Therefore, it is difficult to determine which habitat or habitats are absolutely essential to a certain species. Few species rely completely on a single food source or type of vegetative cover.

As recently as thirty years ago, when about 60 percent of the study area was under cultivation (HA-421, -422, -423), there were virtually no deer or turkey in the area. Most of the woodlands had recently been logged (within 20 years) and were in the mid-pine-hardwood stage with many areas of bushy hardwoods 10-20 feet tall. It is quite likely that many of the birds and small mammals were in greater abundance then than they are now, since the presence of brushy cover and small grain crops would have been ideal habitat. The more mature pine-hardwood and near climax river-edge hardwood forests currently covering more of the area provide less optimal habitat for these animals. The lower populations of small animals combined with the increased presence of man in many areas has probably led to a decrease in larger predators (foxes, bobcats, bears, hawks, and eagles). Although no surveys of the area have been conducted recently, the deer and possibly the turkey populations have increased since the surveys of the late 1940's. This is probably due partly to better game management by the state and more stringent game law enforcement.

Many of the birds and mammals can be either hunted or trapped legally in North Carolina (NO-090). The mammals of major economic importance from the hunting standpoint in the study area are rabbits, squirrels, foxes, and possibly deer. The primary game bird is the bobwhite quail. Some mourning doves and a few turkeys may be taken also. Trappers may take raccoon, oppossum, weasel, skunk, and possibly a mink or beaver; however, it is unlikely that widespread trapping occurs within the study area.

(2) Water

The streams and rivers of the study area contain few true aquatic plants, primarily owing to their swift current, shallow water and rock or sandy gravel bottoms. Where pools form and the bottom becomes somewhat stabilized, Marsh smartweed (Polygonum coccineum), Sago pondweed (Potamogeton pectinatus) and Bladderwort (Utricularia sp.) may become established.

Filamentous green algae may also be present in areas of slower current and more translucent water, especially during the warm summer months. The larger creeks and the Tar River are somewhat turbid and are rich in nutrients from runoff. They have abundant unicellular green algal growths, especially in the summer. The small ponds and lakes generally have the same three types of rooted aquatic vegetation. However, other types brought in by visiting ducks or other aquatic birds may also grow, usually around the shore in water shallow enough to allow sunlight to reach the bottom. Due to its constantly fluctuating level and turbidity, the Nutbush arm of Kerr Reservoir has very little rooted vegetation near the shore.

An overabundance of aquatic vegetation, especially filamentous and unicellular algae, can cause low oxygen concentrations and foul odors in the water. This situation can reduce the quality of the habitat for aquatic animals and be distasteful to humans who use the water for drinking. The creeks and rivers of the study area do not appear to have problems of this type at present. However, the Nutbush arm of Kerr Reservoir near the mouth of Nutbush Creek has the potential for this type of problem.

Fish and some salamanders are the only truly aquatic animals in the study area. Since fish of the study area do not migrate much, if any, they are all permanent residents of their respective locations. They all breed in the streams or lakes. The relative abundance of many of the non-game species is currently unknown. No one species is critical for the survival of other species since the larger predatory game fish do not prey on only one species. The Carolina madtom (Noturus furiosus) is the only species listed whose status is of special concern in the project area (SY-018).

Sandy Creek and the Tar River within the project area are noted as being productive fishing streams. The largemouth bass and several species of sunfish are the primary fish sought by anglers in Sandy Creek. In some areas the sunfish are very plentiful. In both the creek and the river, the benthic fauna are abundant in areas of slow current and proper bottom type (SM-117). Their abundance varies with the time of year and seasonality of the various insect larvae which may comprise a large portion of the benthos. Generally, with the exception of the darters which prefer rocky riffles, the majority of the bottom fish can be found where the benthic organisms are most plentiful. In turn, the predators follow their prey species. Therefore, certain areas such as pools, ponds, and certain bottom types in lakes will be much more productive with respect to fish than other regions of the same creek or lake.

Kerr Reservoir is one of the most popular fishing areas of the region. Recent censuses (1970-71) showed that crappie, bluegill, catfish, bass, sunfish, pickerel, and carp were the most frequently caught species in descending order. The first four accounted for 95 percent of the reported sport catch (WE-222). The deeper creeks such as Sandy Creek, the ponds, and the Tar River provide some very good fishing for bass and sunfish. It is legal to take these and other gamefish during the open seasons with hook and line in the public waters of the study area. Non-game fish may be taken by special devices such as gill nets and traps in some of the ponds and creeks of the study area during the proper season (NO-091). These non-game fish may be sold. There is moderate game-fishing pressure on the larger creeks and Tar River. It is not known exactly how much commercial fishing for non-game species occurs; however, it is probably not extensive.

(3) Land/Water Interface

There are no true wetlands in the study area. The study area includes approximately 130 miles of creek and river banks and 119 impoundments, other than the Kerr Reservoir, with surface areas larger than 5 acres (US-353). Several hundred small farm ponds of 5 acres or less have been constructed on the intermittent creeks. Since Kerr Reservoir is a man-made, variable-level lake, the shore does not contain a diverse vegetation community. The shoreline generally consists of the forest vegetation that was present when the lake was created. The hardwoods are gradually replacing the pines where they are close to lake shore since the pines do not prosper in wet soil. The natural creek and river banks and most of the older ponds have river-edge hardwood vegetation in the rich, alluvial soils where moisture is high. At the water's edge of the creeks and rivers, willows and sycamores are the dominant vegetation. Many varieties of shrubs and bushes also cling to the banks. Their roots, along with the thick mat of leaves they shed each year, help keep erosion and stream siltation to a minimum, thereby keeping the water clear. In some areas such as along Ruin Creek, downstream from the Red Bud Creek confluence, the floodplain bottomlands is quite wide. This area has an almost closed canopy of tree tops which prevents light from reaching the ground during the growing season. Therefore, there are few brushy or ground cover species present. The ground is constantly damp and spongy with layers of decaying leaves present. Shrubs grow only along the edges of roads and the clearings where old trees have fallen. Around the older ponds, such as Weldon's or Southerland's pond, some water-tolerant grasses and ground covers grow.

Many of the amphibians and mammals and some of the reptiles prefer the moister areas near the streams, rivers, and ponds. Some of the birds are specifically adapted to the aquatic areas. Most of the animals must drink water in order to survive. If they are able to find adequate food and shelter near the water, then they need not venture into other areas. Frogs, some toads and most salamanders must return to the water to lay their eggs. Raccoons, opossums, skunks, foxes, weasels, snakes and predatory birds, to name only a few, prey heavily upon amphibians and fish of the water courses. The majority of the animal species found in the study area can be found at one time or the other along the water courses or in the river-edge hardwood community.

Due to the predominance of large hardwood trees along the water's edge, in most cases, these land-water interfaces are not substantially better wildlife habitat than the edge provided by roads, pipelines, and power lines. These man-made edges provide areas of grass and brush that allow a larger variety of species to find their proper habitat. The total primary productivity of the river-edge hardwoods in closed canopy areas is almost completely tied up in the trees themselves. Therefore, those species of wildlife that can use the trees directly benefit the most. Since squirrels eat the nuts and seeds of many of the hardwoods and nest in the treetops, they should benefit greatly from large hardwood areas. The river-edge hardwood plant community that contains some open, brushy, or grassy areas is much better than the closed canopy type from the wildlife standpoint. A larger variety of animals can live in the more diverse habitats.

(4) Sensitive Areas

The habitats of rare or endangered species of wildlife are quite varied. It is not known if certain endangered species, whose ranges cover the study area, actually occur there. None of the species listed as rare, endangered or threatened on the U.S. Fish and Wildlife endangered species list are endemic to North Carolina. One species group is of concern in North Carolina, although total U.S. or international populations are not seriously threatened. This group includes the bald eagle, osprey, other birds of prey, shorebirds, and owls whose populations are decreasing over their entire range (see Table II-9). None of the other animal species listed as rare or endangered in North Carolina (SY-018) are believed to inhabit the study area. There is a possibility that

TABLE II-9

BIRD SPECIES ENDANGERED, THREATENED, OR OF SPECIAL CONCERN IN NORTH CAROLINA*

SPECIES	CLASSIFICATION[1]
Bald Eagle	E
Peregrine Falcon	E
Golden Eagle	T
Merlin	T
American Kestrel	T
Red Tailed Hawk	SC
Osprey	SC
Marsh Hawk	SC
Mississippi Kite	SC
Saw Whet Owl	T
Barn Owl	SC
Black Duck	SC
Great Blue Heron	SC
Black Crowned Night Heron	SC
Common Gallinule	SC
Piping Plover	SC
Red-Cockaded Woodpecker	E
Black Billed Cuckoo	SC
Eastern Bluebird	SC
Prothonotary Warbler	SC
Red Crossbill	SC
Pine Sisken	SC

*Not all species listed here necessarily occur in the Henderson area; for further information on species classified as endangered, threatened, or of special concern in North Carolina, see SY-018.

[1] E = endangered
T = threatened
SC = of special concern

some moss species listed as rare may occur on large rock (gneiss or schist) outcrops within the study area (PA-230). However, during the brief site visits, none of these large outcrops were found. In summary, the study area contains no specific areas which are considered more biologically sensitive than others in the same habitat type.

b. Site-Specific Descriptions

To develop site-specific descriptions, field surveys were performed in the areas being considered. The following discussion describes observations from these surveys along Nutbush Creek, Red Bud Creek, Martin Creek, and Sandy Creek.

(1) Nutbush Creek

The portion of Nutbush Creek from the present sewage treatment plant to its mouth at the Nutbush Creek arm of Kerr Reservoir is covered primarily with river-edge hardwood vegetation in the floodplain grading into pine-hardwood on the more sloping, drier areas. The area upstream of the treatment plant was not surveyed since the pipelines will go along roads and not affect the stream except at crossings.

The dominant trees in the floodplain between the plant and County Road 1317 are sycamore, box elder, black willow, silky willow, and alder. The understory is dense buckeye, red bud and small trees. The ground cover is primarily honeysuckle, poison ivy, and Virginia creeper near the creek with some weedy species (chickweed, ragweed, knot weed, and several grasses) along the creek banks in sandy places.

The drier slopes contain loblolly pines, sweetgum, tulip poplar, American elm, and southern red oak as the dominant tree species. The understory is mainly small trees of these types with some buckeye, red bud, black cherry, and black locust. The ground cover is more varied with several species of wildflowers and ferns. Spotted wintergreen, false solomons seal, running "cedar," and poison ivy are common.

The trees in this portion of the creek appear to be about 75 years old. This seems to be the length of time since the area was last logged, judging from the state of decay of the stumps. Most of the hardwood species are in the .3 to .5 meter diameter at breast height (dbh) range. The pines are in the .3 to .75 meter dbh range.

The creeks proper (Nutbush and the sidearm by the treatment plant where the outfall is located) are devoid of most forms of life from the plant to the County Road 1317 crossing. The anoxic black sediments bubble with hydrogen sulfide gas at the slightest disturbance. This condition precludes the existence of any but the most rudimentary forms of aquatic life.

No evidence of fish, mammal, bird, amphibian, or reptile activity was found in or near the creek. Only a few deep-forest birds were seen or heard. Should the water quality be upgraded in the creek, the animals will re-populate the area since the rest of the habitat is in good condition. The vegetation does not appear to be affected by the condition of the creek.

Below the 1317 bridge, the water quality is visibly improved; however, the odor is still strong. The vegetation between the bridge and Kerr Reservoir is much the same as that in the upper section. There are sections of very low, moist hardwood forest with large trees and a dense ground cover of wild chervil, wild garlic, and chickweed. These are interspersed with slightly higher, drier areas containing less ground cover, some loblolly pines and a sparse understory of box elder and small trees. The floodplain widens near the creek mouth as it grades into the reservoir. This area is mostly river-edge hardwood with a dense, moist ground cover similar to that mentioned above.

Raccoon tracks, frogs, and some benthic worms were noted in and around the creek proper. The water was clearer but did not appear to contain much algae. A type of brown slime mold was seen growing on the rocks in the creek. No fish were seen in the creek at this point; however, as with the upper section, this portion will be re-populated as the water quality returns to a more natural state. There were several types of deep woods birds around the creek. A small heron was also seen in the creek.

(2) Red Bud Creek

The vegetation of Red Bud Creek from the present sewage treatment plant to the golf course (where a new pipeline is planned) is predominantly river-edge hardwoods. Beech, willow, sycamore, red maple, northern red oak, American elm, southern red oak, tulip poplar, sweetgum, and red cedar are all present. This is a very mixed association without strong dominance by one or a few species. The understory contains abundant alder, buckeye, and box elder. The ground is moist in many places and is covered with elderberry, honeysuckle, wild chervil, and many other forbs and herbs. The trees appear to be about 50-60 years old, judging from their size and the evidence of past logging.

In several areas the floodplain narrows with an increase in the slope of the sides. The drier pine-hardwood vegetation encroaches into these areas. Loblolly pine is common with some wildflowers and dry-area ferns present as ground cover. These areas of natural vegetation are small; most of this portion of Red Bud Creek has been urbanized.

The creek itself is quite small, with a clay/sand bottom and steep sides. Mosses grow on the banks to the water's edge. The water was clear and flowing during the site visits. No filamentous algae were evident. Enough unicellular algae were present in the water to give it a slightly green tint, but not enough to decrease light penetration.

The presently used gravity sewer from Henderson to the Red Bud Creek treatment plant runs along the north side of the creek bed. The easement is mowed to a width of about 20 meters. This area is covered with wildflowers and grasses. The edges of the forest along the easement have dense growths of young trees, honeysuckle, and other brushy types of vegetation. This creates good "edge" habitat for animals such as rabbits, squirrels, raccoons, foxes, and many types of birds. This area generally typifies the proposed sewer line easements after revegetation.

Evidence of many types of animal life was found along the creek and the immediate vicinity. Raccoon tracks, frogs of several types, and several species of deep woods birds (cardinal, redstart, yellow throat, woodpeckers) were noted. No doubt many other species also live in the area and feed in or near the creek.

(3) Martin Creek

Martin Creek was investigated between its confluence with Sandy Creek and the U.S. 1 crossing where the pipeline is planned. The vegetation can be characterized as river-edge hardwood with intrusions of pine-hardwood vegetation in areas where the floodplain is narrow and more steeply sloped. The dominant trees of this area are mockernut and pignut hickory, white oak, sweetgum, winged elm, and tulip poplar. The understory is mainly young trees of the preceeding types and smaller trees such as black gum, alder, and dogwood. The ground cover in the closed canopy areas is poison ivy, ferns, and other bog-type plants with thick mats of honeysuckle on the edges where the suns penegrates. The trees in these closed canopy areas are about 50 years old. These areas show no evidence of recent logging.

In the drier, more well-drained, steeper sloping areas, the younger (less than 50 years old) pine-hardwood forest has a denser understory of blackgum and dogwood along with many more young trees of the dominant loblolly pine and oak species. This area also supports more species of wildflowers as well as dry-area ferns and a stand of native bamboo near the stream.

The creek is too small to support a permanent population of sizeable fish; however, the presence of raccoon and oppossum tracks along with an abundance of various types of frogs indicates that several species of animals depend on the stream for food. Many species of forest-dwelling birds (cardinals, warblers, vireos, etc.) appear to live in the area.

The creek itself was small, flowing with clear water and showed no evidence of recent disturbance at the time of the site visit. The effects of past logging and the cutting of roads across it have all been covered over by the vegetation. The vegetation was generally dense to the very edge of the creek. No rooted aquatic plants were seen, nor were any algae visible to the naked eye during the site visits.

(4) Sandy Creek

The vegetation along Sandy Creek from Laurel Mill upstream to the City of Henderson can be characterized generally as moist, dense river-edge hardwoods along the broad floodplains in most of the lower reaches, with a gradual change to more pine-hardwoods on the drier slopes of the upper reaches. Some areas of rock outcrops such as Laurel Mill have narrow, steep floodplains with more nearly a pine-hardwood forest cover. The dominant trees in the Laurel Mill area are river birch, ironwood, and alder, as well as a mixture of a dozen other species. The common understory species are mountain laurel (from which the site derives its name), dogwood, and holly. There are also many sedges, rushes, grasses, and vines. The rock outcrop at the Laurel Mill site contains several lichens, mosses, cacti, and red cedar.

A large area several miles upstream from the Mill near the 1412 crossing contains a vegetation assemblage worth noting. The floodplain is over 200 meters wide and very flat with multiple channels branching through an area several miles long. The trees of this area are all between 0.5 and 1 meter diameter at breast height, with many over 40 meters tall. This area has not been logged in an extremely long time and there is no evidence of man's activity in the area. It must be considered a near-climax hardwood forest. There is no understory and very little ground cover. Poison ivy is the dominant ground cover, climbing into the canopy on many of the ten species of giant trees. Jewelweed is also abundant in the small openings in the canopy. Of special note are several loblolly pines growing in the boggy ground. They are all about 1 meter dbh and in excess of 40 meters tall. They do not normally grow in such wet soil. This forest also contains some very large specimens of river birch and red maple. Outside the floodplain, the forest grades into a pine-hardwood type on the better-drained soils. This forest contains many more understory plants and some ferns and wildflowers on the forest floor.

Progressing upstream and up in elevation from about 40 meters to about 120 meters, the forests change to upland hardwoods with some pine intermixed. Many of these have been logged and stumps can be seen over much of the area. Some logging is presently taking place about three kilometers below Southerland's Pond.

In various ponds including Laurel Mill, Southerland's Weldon's, Club, Roland, and Fox, many types of aquatic plants can be found. Cattail, parrot-feather, rushes, sedges, Peltandra, and other aquatics grow in profusion in some of the ponds. Some filamentous green algae were noted in the shallows of several of the ponds during the site visits, even though it was still slightly cool for good growth in May, 1976. The water was generally green with unicellular algae but no real blooms were noticed.

In the upper reaches of Sandy Creek above Roland Pond, the creek bed crosses several gneiss outcrops. Talinum teretifolium (an endemic moss) was found on one small outcrop. There are several other species of endemic plants that grow on large outcrops; however, none of these were seen. Two of these, Arenaria uniflora and Portulaca smallii, are considered endangered (SY-018). There is a good possibility that these plants may be found on large, exposed gneiss or schist outcrops in the area (PA-230).

The stream itself was free-flowing and slightly green with unicellular algae. The rock pools in the upper reaches and the man-made ponds harbor sunfish, catfish, bass, and many other species. Bluegill, rockbass, and red breast sunfish were found in the rock pools along with many immature sunfish. This indicates that they are breeding in the headwaters of Sandy Creek. Many species of birds were seen in the vegetation around the creek and in the creek itself. Several hawks were seen over the wooded areas. Many species of birds nest in the river-edge hardwoods. Squirrels, raccoons, rabbits, skunks, a few deer, and possibly some weasels live in the river-edge hardwoods along Sandy Creek. Evidence of these was found along the creek. The diversity of habitats within the vegetation and the waters of the creek make Sandy Creek a biologically rich and diverse area.

B. Man-Made Environment

The man-made environment has been identified as those things present in the total environment which are the products of man and his social structure. For the purposes of this discussion, the study area has been broadened somewhat. Data are presented for all of Vance, Franklin, and Warren Counties; however, the focus of the study remains on Vance County and the City of Henderson. Included in the analysis of the man-made environment are demography, economics, and economic geography. Supporting documentation may be found in the Technical Reference Document (RA-R-276).

1. Demography

Several Indian tribes inhabited the study area until as late as 1776. Most prominent among these tribes were the Saponi. It is said that the Saponi and the early settlers named Nutbush Creek, reflecting the abundance of hazel nuts found along the creek bank (PE-176). The Creek Nation occupied the area along Nutbush Creek, and the Tuscaroras, a warlike tribe, were common in what is now Southern Vance County (PE-176).

The area which was to become the town of Henderson was settled in 1789 by Samuel Reavis and his three sons. In 1835, the town was formally named Henderson for Leonard Henderson, the first Supreme Court Justice of North Carolina and received its charter in 1841. Henderson marked the dividing line between the cotton lands of the East and the tobacco lands of the West, when the town entered the leaf tobacco market in 1872. In the boom years of its tobacco auction market, Henderson was referred to as a "tobacco town" (PE-176).

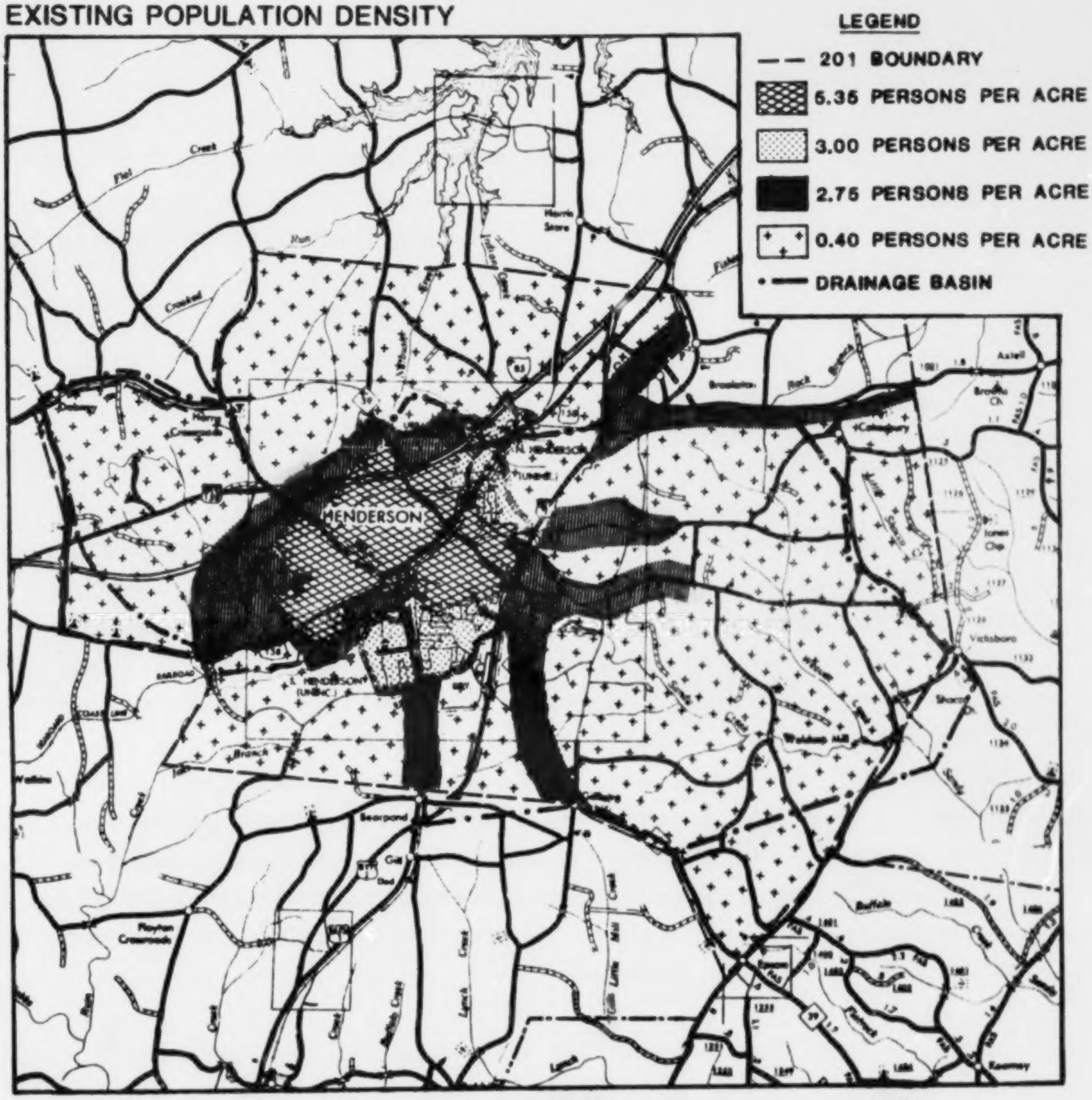
In 1881, Vance County, named after Zebulon Baird Vance, then governor of North Carolina, was formed from the counties of Granville, Warren, and Franklin. The population of the new county was 9,000 (PE-176).

a. Current Population

The population of the study area has experienced a total growth of 5.7% since 1920, as compared to the total growth in population of the entire state of 98.6%. Population growth within the study area has not been constant, as populations in Franklin and Warren Counties have declined since 1950. Vance County also experienced a population decline beginning in 1950, but this trend reversed itself and by 1960 population in Vance County began increasing. A reason for declining population is outmigration to industrial jobs as a result of declining labor requirements in agriculture. Consequently, if the population of the three-county study area is considered by age groups, a trend of decline in the very young and in working-age men and women is apparent. Concomitant increases in the number of older people (60+) is also notable. Warren County exhibits this population age shift most strongly.

The City of Henderson has accounted for much of the population growth of Vance County. In 1920, Henderson constituted 22.9% of the county population; by 1970, this figure had grown to 42.5%. Figure II-17 displays population density within the City of Henderson. A trend to outmigration of the very young and working-age men and women is noted in Henderson, corresponding to outmigration patterns in the county as a whole Thus, it appears that the Henderson statistics are similar to those of Vance County, but the Henderson trend to population decline is largely ameliorated by percentage increases in male age groups 15-19 years and 20-24 years, indicating that the city is attaining favorable growth among the younger male age groups.

EXISTING POPULATION DENSITY


LEGEND
201 BOUNDARY
5.35 PERSONS PER ACRE
3.00 PERSONS PER ACRE
2.75 PERSONS PER ACRE
0.40 PERSONS PER ACRE
DRAINAGE BASIN
HENDERSON
N. HENDERSON
HENDERSON (UNINC.)
Harris Store
Bearpond
Vicksboro
Kearney

	EXISTING POPULATION	%	AREA SERVED IN ACRES	DESIGN YEAR 1999	%	AREA SERVED IN ACRES
NUTBUSH CREEK BASIN	6000	40	1385	9750	39	2000
SANDY CREEK BASIN	5800	39	825	10,000	40	2800
RED BUD CREEK BASIN	3200	21	567	5200	21	1600

POPULATION DENSITY
HENDERSON 201 FACILITIES PLAN
HENDERSON, NORTH CAROLINA
FIGURE II-17

The sex composition of the three counties shows no great difference from that of the State of North Carolina. There is a slightly smaller percentage of males in all three counties than the state average.

The study area tends to be more biracial than the rest of the state. In Henderson, for example, 41% of the population is black. The blacks in the study area are typically poorer than the whites, exemplified by the fact that 97% of the substandard housing is occupied by blacks (HE-170).

The average educational attainment in the three-county area is lower than that for the state. However, the City of Henderson has levels of average educational attainment higher than the statewide average. The total enrollment of Henderson approximates 8,000 students and may be divided as follows: approximately 54% attend the 12 elementary schools; approximately 25% attend the area's two junior high schools; and approximately 28% attend the high school (Henderson Board of Education). (See Figure II-22.)

In 1970, the median family income for the study area was considerably below the state average of $7,774. Franklin, Vance, and Warren Counties had family incomes of approximately $5,837, $6,807, and $4,997, respectively, while the City of Henderson had a mean family income of $7,405. In both Franklin and Warren Counties, more than 50% of the families have incomes below the poverty level.

b. Projected Population

The Department of Commerce Office of Business Economics Analysis and Economic Research Service (OBERS) Series E population projections for the Tar-Neuse Water Resources Subarea, of which the study area is a part, show increases of 10.7%, 18.0%, 13.7%, and 8.5% for the years 1970-1980, 1970-1985, 1980-1990, and 1990-2000, respectively. These estimates are slightly higher than the corresponding ones for the nation (US-122).

Several population projections and estimates have been made for Franklin, Vance, and Warren Counties and the City of Henderson. The latest estimates of the Bureau of the Census for North Carolina and the three counties are shown in Table II-10. The trends presented in this table indicate that both Franklin and Warren Counties, which have experienced population declines since 1950, might possibly have overcome the downward trend and could experience population and economic growth again. Vance County is continuing its population vacillation around the 32,000 people figure that has been applicable since 1950. Henderson is the largest community in the three-county area and the center of economic opportunity. Any population increases should be noted first and most strongly in Henderson.

TABLE II-10

POPULATION ESTIMATES

	1970	1972	1973
North Carolina	5,082,059	5,221,000	5,273,000
Franklin County	26,820	27,500	27,800
Vance County	32,691	32,000	32,300
Warren County	15,810	16,900	17,200

Source: US-437

On the other hand, the population projections of the North Carolina Department of Administration show a decrease in the 5-19 year old age groups for 1980 for all three counties. These projections would indicate a decrease in total population in each county, with the least decline occurring in Vance County.

Moreover, data presented in both the Facilities Plan for the Henderson area and in the April 1976 E OBERS Projections (reproduced in Table II-11, below) indicate that while Vance County will experience very little growth in the future, the City of Henderson is expected to experience a "moderate" growth rate.

TABLE II-11

POPULATION PROJECTIONS

	VANCE COUNTY		CITY OF HENDERSON		201 AREA*
	PROJECTED POPULATION	PROJECTED POPULATION INCREASE	PROJECTED POPULATION	PROJECTED POPULATION INCREASE	
1970	32,691		13,898		
1975	33,100	1.3%	15,100	8.6%	
1980	33,500	1.2%	16,530	9.5%	25,334
1985	33,800	0.9%	18,100	9.5%	
1990	34,200	1.2%	19,425	7.3%	27,640
1995	34,400	0.5%	21,200	9.1%	
2000	34,700	0.8%	23,025	8.6%	29,260

Source: WO-086

*April 1976 E OBERS Projections

2. Economics

The economy of the study area consists chiefly of the manufacturing, agricultural, and wholesale/retail sectors. The labor force available in the three-county study area has undergone a substantial increase from 1970 to 1973, indicating a stabilization of the area's economy as opposed to an economic downgrading as might be expected from declining population trends.

The manufacturing sector of the economy has experienced the largest increase in employees in all three counties as well as Henderson. In 1970, there were more than 8,300 manufacturing establishments in North Carolina, employing over 35 percent of the total number of people employed in the state. Franklin, Vance, and Warren Counties had similar percentages of employment in manufacturing. There were approximately 60 establishments in Franklin County, 40 in Vance County, and 40 in Warren County. The Vance County industries were typically centered in or around Henderson and employed approximately 7,000 workers. The principal industries in Vance County are textiles, chemical, and food manufacturing (US-343).

The dramatic growth in the manufacturing sector from 19.5% in 1960 to 34.4% in 1970 is accompanied by a significant decline in farm employment. Agricultural employment percentages in 1970 were approximately one-third of the 1960 values. Much of this decline is due to fewer farms as well as to increased mechanization of farming equipment with resultant reduced labor requirements.

Wholesale/retail trade, the second largest employment sector in the three-county area, gained largely due to increases in Vance County. At the same time, Franklin and Warren Counties experienced either slight growth or slight decline in this sector.

Projections of total earnings by industry are presented in Table II-12. Overall, these data are very similar to that of the nation with the exception of the manufacturing sector, where large regional gains are expected. Population projections previously discussed predict that much of the percentage increases in the study area will be in the 15 - 24 age groups which normally supply the labor force. Such a large increase in available regional labor will tend to make the three-county study area attractive for potential industrial sites. Employment is, therefore, projected to increase (See Table II-13).

TABLE II-12

TAR-NEUSE WATER RESOURCES SUBAREA
PROJECTED PERCENTAGE OF TOTAL EARNINGS BY INDUSTRY

	1970	1980	1985	1990	2000
Agriculture	9.1	6.3	5.3	4.5	3.4
Mining	--	0.3	0.3	0.3	0.2
Contract Construction	5.4	5.5	5.4	5.3	5.1
Manufacturing	22.9	25.6	26.2	26.8	26.9
Transportation, Communication, Public Utilities	4.5	4.5	4.5	4.5	4.6
Wholesale & Retail Trade	15.5	14.3	13.8	13.4	12.7
Finance, Insurance & Real Estate	4.8	5.3	5.4	5.6	5.8
Services	13.2	15.2	16.0	16.8	18.4
Government	23.8	[illegible]3.0	23.0	22.9	22.9

Source: US-122

TABLE II-13

PROJECTED EMPLOYMENT, 1980

	Franklin	Vance	Warren
Total Labor Force	13,685	19,808	6,584
Unemployed	693	990	330
Total Employed	13,172	18,818	6,254
Agriculture	1,976	1,317	938
Non-Agriculture Wage and Salary	10,010	15,054	4,690
Other	1,093	225	625

Source: KE-175

3. Economic Geography

Economic geography can be defined as the distribution of economic activity. In this context, the distribution may be either spatial or temporal. Economic geography includes studies of land use, land-use planning, land use controls, and resource uses.

Maps displaying specific land uses are presented at the end of this section. It is foreseen that areas outside the study area will be affected by and will affect the proposed action. These particular areas of interest will be noted in the text.

Vance County will form the basis of the economic geography study area. Vance County comprises approximately 269 square miles, the majority of which is rural, with approximately 1,500 farms of an average size of 70 acres each. Four incorporated towns, Henderson, Kittrell, Middleburg, and Townsville, and several smaller communities are included in this county.

a. Land Use

Henderson township, which includes the city and several adjacent unincorporated areas, encompasses a total area of approximately twelve square miles. About 64% of the total population of the study area resides here. The majority of residential land use is, consequently, within Henderson township.

The corporate limits of the city account for 7.1 square miles (60%) of the total land area of Henderson township. In 1970, approximately 14,000 persons resided in the City of Henderson.

The current pattern of residential land use in the area is a concentration of housing around the county seat, Henderson, and strip housing along most rural roads throughout the county (Figure II-18). Housing along rural roads accounts for the great majority of rural housing in the county. This land use consists of single-family dwellings, multi-family dwellings, mobile homes, and mobile home parks. The multi-family housing outside of Henderson is limited. Mobile homes are very important in the housing market and will continue to be until the supply of low- to moderately-priced housing is increased.

The white population is generally distributed throughout the central, southwestern, and southeastern portions of the city, while blacks occupy areas located in the eastern and northwestern portions. The lack of some or all plumbing facilities is evident in 21% of all city homes; 84% of these units without some plumbing facilities are occupied by blacks (US-016). The vast majority of these sub-standard homes have family incomes which average of $2,667, well below the poverty level (US-016). Nearly 48% of all families and unrelated individuals have annual incomes of less than $7,000 which make them eligible for housing assistance either in the form of mortgage-interest subsidies or rent supplements.* There are currently 158 rent-subsidized dwellings in Henderson.

Local builders and developers have generally been reluctant to build homes with values less than $17,000 or apartments that rent for less than $100.00 per month. In 1973, local construction had 37 new housing starts, 76% of which had building permit cost estimates of $12,000 and up. These units are not available to low and moderate-income families. Currently, there are only two rent-supplement developments. One consists of 50 units of Section 236 (HUD) apartments which rent for $90.00 to $95.00 per month, and another includes 108 units of Section 221 (d) 3 (HUD) apartments which rent for $135.00 to $195.00 per month (HE-170).

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*Family size formulae render some individuals ineligible.

The pattern of developed commercial land use in the study area is typical of a predominantly rural/agricultural region (Figure II-19). The farm-to-market roads are dotted with retail establishments. Downtown Henderson is also a vibrant area. Its shopping center area should develop further, along with the land area at the interstate exchanges. Additional highway business will continue to increase around Kerr Reservoir and along U.S.-1 By-Pass, U.S.-158 By-Pass and N.C. 39. Other convenience centers will cevelop in the community clusters (KE-164). However, Henderson will remain the center of economic activity in the county, with the preponderance of growth with respect to future commercial land use within the urban part of the study area (HE-169).

Vance County is traversed by Interstate Highway I-85 (east to west) and U.S.-1 (north to south). North Carolina Highway 39 (north to south) has recently been widened and completed. Most secondary roads are paved. The generally good network of roads in the county facilitates marketing and commuting by workers. A small airport also serves the area. The Seaboard Coast Line Railway Company and Southern Railway System provide freight service to Henderson. Additionally, industry in the area is served by fifteen major trucking firms. Other small trucking firms and individuals serve agricultural, textile, pulpwood, mining, manufacturing, construction, wholesale, and retail industries (NO-093).

The study area has approximately forty industries centered in Henderson where the majority are located in the south, southeast, and northeast sections (Figure II-20). Principal industries are textiles, chemical production, food, mineral, glass containers, mobile-homes, and garment manufacturers. The only active extractive industry in the study area is the Graystone Quarry located northeast of Henderson (Figure II-21).

The area has only two institutional land-use facilities other than the public schools previously mentioned. They are Kittrell College (2-year) and Vance-Granville Technical Institute (Figure II-22).

The topography of Vance County lends itself to agricultural development. Tobacco is responsible for 75 percent of the farm income ($8,000,000 annually). The tobacco industry in Vance County requires between 6,500 - 7,000 acres for annual production. Of particular note for this study is the large percentage of tobacco farms that require extensive irrigation during the dry summer months. Other crops grown in the county are cotton, cucumbers, grain, and forages (NO-093).

Production of pulpwood is an important activity and often supplements farming incomes. Approximately 96,000 of the total 160,000 forested acres of Vance County (Figure II-23) are commercially owned (FR-171). Presently, most of the woodlands are in relatively small tract ownership and are, therefore, not easily managed for maximum commercial efficiency. The main commercial species is yellow pine, but hardwoods are also grown. In addition to providing an additional economic base, the forests of Vance County provide a setting of natural beauty for urban and rural recreational use.

Vance County contains a total of 2,160.5 acres devoted to recreational use (Figure II-24) (NO-094). The estimated attendance on an annual basis is in excess of 1,200,000 people which is a significant indication of high utilization of most park facilities. Currently planned expansions and additions to recreational resources are shown in Figure II-25. Parks for various purposes are scattered throughout the county, although swimming facilities are few and restricted to the urban area. The abundance of natural beauty and the gentle terrain are basic ingredients in the development and utilization of the recreational system now in operation in Vance County.

The North Carolina inventory of historical sites lists 18 sites within Vance County and these are shown on Figure II-26. To date, three of these sites have been included in the National Register of Historic Places. These sites are Ashland Plantation, Burnside, and St. Johns Episcopal Church. Each of these sites is briefly described below.

Ashland: Built in 1740 by Samuel Henderson, Ashland was the home of Richard Henderson and later Leonard Henderson, the first Supreme Court Justice of North Carolina for whom the town of Henderson is named. Richard Henderson is noted for being the first to open the West for settlement. Despite King George III's Proclamation of 1773, Henderson dispatched Daniel Boone in 1774 to purchase 35,000,000 acres of land from the Cherokee Nation and to establish a colony to be called Transylvania (PE-176). The home is considered to be a classic example of colonial architecture (KE-164).

Burnside: Located about three miles west of Williamsboro, Burnside was the home of Mary Pinckney Hardy, mother of General Douglas McArthur (KE-164). The grounds of the home were used for camp by General Sherman on the march to Atlanta (KE-164). The exact date of construction of the home is not known, but it has been described as characteristic of the Classic Revival Period (PE-176).

St. Johns Episcopal Church: A restored colonial church built in 1773, St. Johns is located in Williamsboro. It is considered to be the oldest church in Vance County (KE-164).

National Register sites, sites approved for National Register nomination, and state-designated historical sites in Franklin and Warren Counties which are within the potential impact area of the proposed project have also been included in Figure II-26. National Register sites and those sites approved for nomination are described below.

Franklin County:

Dean Farm: Well-preserved farm complex includes Greek Revival house with pedimented ends which is an unusual style in the county.

Patty Person Taylor House: A 5-bay, two-story Georgian house with a center-hall plan, apparently unique in the county for the period. Home of the sister of anti-Federalist leader, General Thomas Person.

McLemore-Cannady House (Approved for National Register nomination): Essentially unaltered 3-bay, two-story frame Georgian house.

Willie Perry House (Approved for nomination): Well-preserved large L-shaped house; rear, ell Federal, front section, early Greek Revival.

Cooke: Judge Charles Mather house.

Battle-Malone-Bass House (Approved for nomination): Large two-story frame Georgian plantation house with double-shoulder chimneys of brick laid in Flemish bond.

Person-McGee House (Approved for nomination): Federal or Georgian rear section and Queen Anne-style front section; large well-preserved and to be considered one of two very good examples of Queen Anne style in the county.

Locust Grove: Two-story, 5-bay Georgian-style structure.

Laurel Mill: Not in Vance County, but of particular interest to the 201 Project is Laurel Mill which is listed in the National Register of Historic Places. It is a restored turbine grist mill on Sandy Creek in the Gupton vicinity. The original mill was built around 1868; the old rock dam was rebuilt in 1938.

Warren County:

Green Duke House: Unusual and architecturally significant Georgian plantation house with circa 1900 remodeling and alterations; home of one of the earliest families to settle in what is now Warren County.

A more extensive list of historical and cultural sites for the entire study area is provided in the Technical Reference Document (RA-R-276).

No systemmatic archaeological investigations have been conducted in the Henderson area (TH-109). No archaeological sites within Vance, Warren, or Franklin counties have been included in or proposed for inclusion in the National Register of Historic Places. However, archaeologists do believe that there is a "high likelihood" of sites within the Henderson 201 Planning Area (TH-109). Their assumptions are based on the existence of numerous stream junctions and stream valleys within the area. These are high probability areas for archaeological sites. In addition, an inventory performed for the Roanoke Dam and Reservoir Site approximately 20 miles northeast of Henderson did result in several archaeological sites indicating that archaeological resources are present in the area.

It is anticipated that all occupation periods would be represented. Paleo-Indian sites have been found in the Henderson area and several projectile points have been located in Vance County. During the archaeological inventory for the Roanoke Dam and Reservoir northeast of Henderson, late Archaic with middle and late Woodland occupation types were found. Generally, middle and late Woodland types are likely along the fall line of the Piedmont range. Sites from Archaic occupation periods are not as predictable but this is probably due to the scarcity of area investigations (TH-109). Any archaeological resources located within the Kerr Reservoir Recreational Area operated by the Corps of Engineers and the publicly-owned commercial forests region are protected as parts of government programs.

(1) Current Land-Use Planning

Currently, the State of North Carolina is in the process of establishing a state-wide Land Policy Act. The activities for this Land Policy Act began in April, 1974, with the passage of legislation. The legislation essentially establishes the Land Policy Council. The duties of the Council are to research, coordinate, and generate legislation to be presented to the executive branch of the state by July, 1977, and to be passed by the legislature by January, 1979. The legislation will, in effect, establish five classifications of land. The Land Classification System will become a basis for statewide planning and will be a guide for future state government investments. Other than the activities involving the "Land Policy Act," the state is not involved in current land planning activities involving Vance County.

The Region K (Kerr-Tarr) Council of Governments is presently not involved in any specific land use planning project as indicated in their overall program design update. The next specific program is scheduled for FY 76-77. Currently, there are COG programs ongoing which could possibly affect future land use in the study area. These studies are concerned with regional transportation and regional growth management. Scheduled to begin in FY 76-77 are studies concerning land use planning, transportation, regional growth management, and a survey of regional environmental problems (KE-167).

Vance County and the City of Henderson created a joint planning commission as of November 9, 1970. Current planning by this commission has produced a County Mobile Home Regulation and County Master Recreation Plan and seems otherwise to be involved in recruitment of industrial investments for the county (OR-022).

Current planning activities at the city level are conducted by the City of Henderson, Planning and Community Development Department. This city department is relatively young and is involved currently in an inventory, classification, and update of existing planning data. Future land uses have been projected only through 1977 at the present time; these land uses are shown in Figure II-27.

(2) Land Use Controls

Enabling legislation for city and county governments is found in the general statutes of the State of North Carolina, Chapter 153A, Article 18, entitled "Planning and Regulation of Development." Part 2 grants powers of subdivision regulation; Part 3, zoning; Part 5, community development (i.e., county may accept state and federal funds for community development programs and activities); and Article 19, creation of regional planning commissions. Also, Chapter 160A, Article 19, covers planning and regulation of development (GR-202, MI-209).

Henderson/Vance County is a participating member of the Region K Council of Governments as established by executive order of the governor of North Carolina in 1970. This agency, located in Henderson, has multi-staff capabilities under the administration of an executive director. The Kerr-Tarr Council of Governments has been designated as the area-wide clearinghouse for the five-county area. In addition to serving as the area-wide clearing house, this agency administers programs on aging, nutrition, and HUD, Section 701 Comprehensive Planning Assistance.

The following organizations are principally responsible for the development and implementation of comprehensive plans directly affecting Henderson.

Henderson City Council - The legislative powers of the city are vested in the City Council. The Council is responsible for appointments to the Planning Board, Redevelopment Commission, and Housing Authority and for final policy approval of the goals and objectives of the respective planning programs.

Henderson Planning Board - The Planning Board has primary responsibility for the development of comprehensive plans and implementation and enforcement assistance related thereto. The Planning Board must be capable of advising the City Council on all matters pertaining to planning and the physical development of the city. The Planning Board should also coordinate the efforts of diverse agencies dealing with development in the Henderson area. The Planning Board presently consists of ten members. The membership includes representation from the extra-territorial planning area in order to develop and effectively implement area-wide plans. This agency has completed a comprehensive zoning ordinance for the city and extra-territorial planning area. The ordinance was adopted by the City Council, effective July 1, 1974 (HE-170).

Another potential land use control, under the HUD Flood Insurance Program, has not been applied by the City of Henderson or by Vance County (NO-092).

b. Resource Use

The vast majority of electrical power for Vance County/Henderson is supplied by Carolina Power and Light (CP&L). Other suppliers are Wake Electric Membership Corporation and Mecklenburg Electric Cooperative. Electric service for the area appears to be quite adequate. The annual electrical power consumption for Vance County is shown in Table II-14.

TABLE II-14

ANNUAL ELECTRIC POWER CONSUMPTION FOR VANCE COUNTY

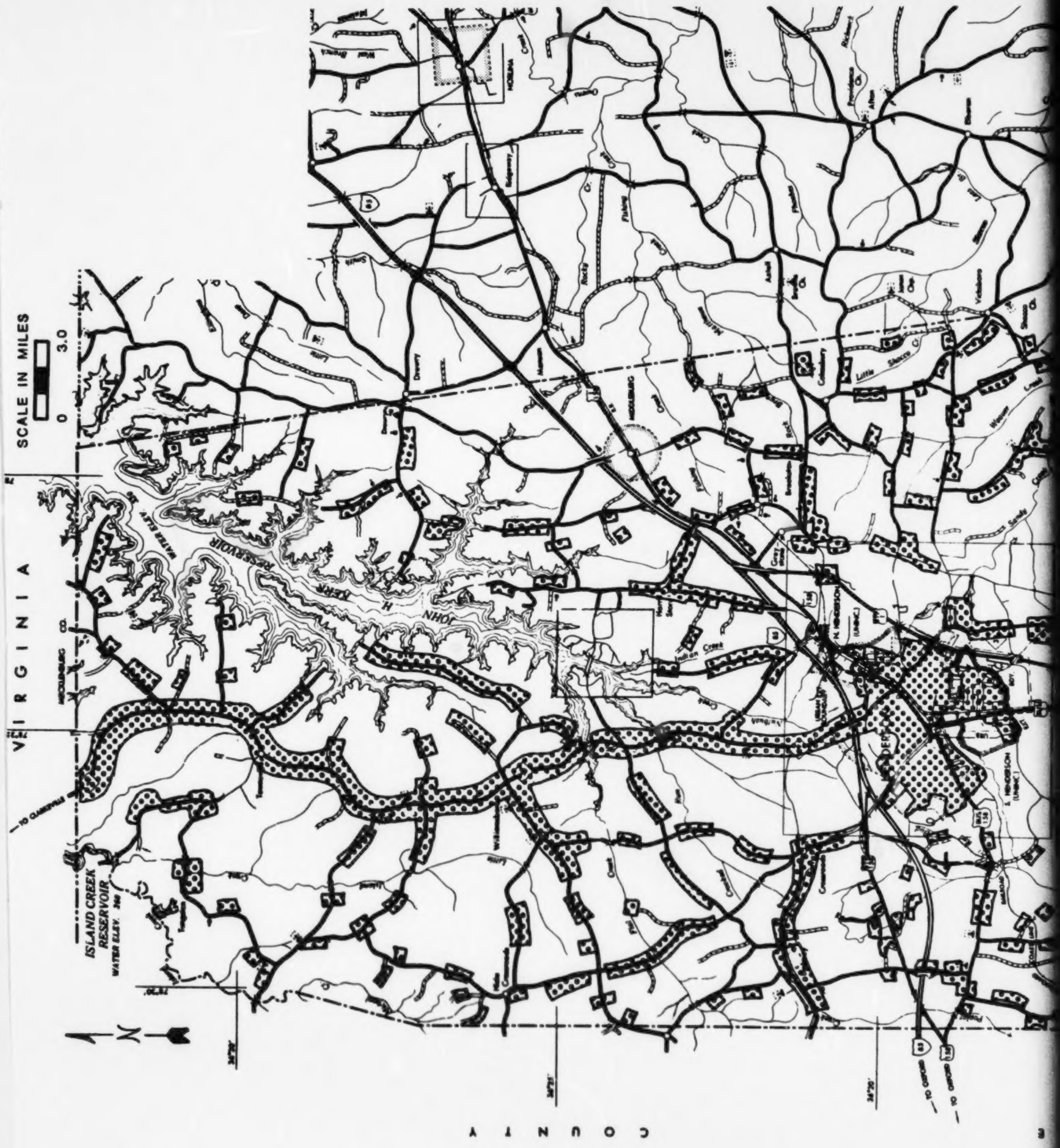
SECTOR	CONSUMPTION (kWhr)
Residential	112,800,000
Commercial	52,500,000
Industrial	192,000,000
Street Lights & Government Use	5,000,000
Total Annual Use	362,300,000

Source: JA-143

The projected annual growth rate for Vance County electrical consumption is 7.5% compounded annually. Projecting this growth rate for ten years gives a figure of 746,700,000 kilowatt-hours for the annual electrical consumption. The availability of power to meet projected needs depends on construction funds available.

At present, the study area has only one active natural resource user, the Graystone Quarry northeast of Henderson. This quarry produces aggregate for use in concrete. The production began in the 1830's, and the quarry is now operating at a reduced production rate. In the event that I-85 is completed, the possibility exists that the quarry will again resume normal operations.

Of note is the existence of one of the largest tungsten mines in the U.S. within the study area. The mine is located 2.9 miles northwest of Townsville and 13.4 miles north-northwest of Henderson. This is the site of the Tungsten Queen Mine. The property was discovered in 1942 by Joseph and Richard Hamme who were searching for strategic minerals for use during World War II. Later, between 1951 and 1958, the mine was the largest single producer of tungsten concentrates in the United States. Market conditions forced the closing of the mine on June 30, 1958. On June


V I R G I N I A
SCALE IN MILES
0
3.0
JOHN H. KERR RESERVOIR
WATER ELEV.
ISLAND CREEK RESERVOIR
WATER ELEV. 260
MIDDLEBURG
N. HENDERSON
S. HENDERSON
Little Shocco Cr.
Indian Creek
Nutbush
TO CLARKSVILLE
TO OXFORD
TO OXFORD
N
C O U N T Y

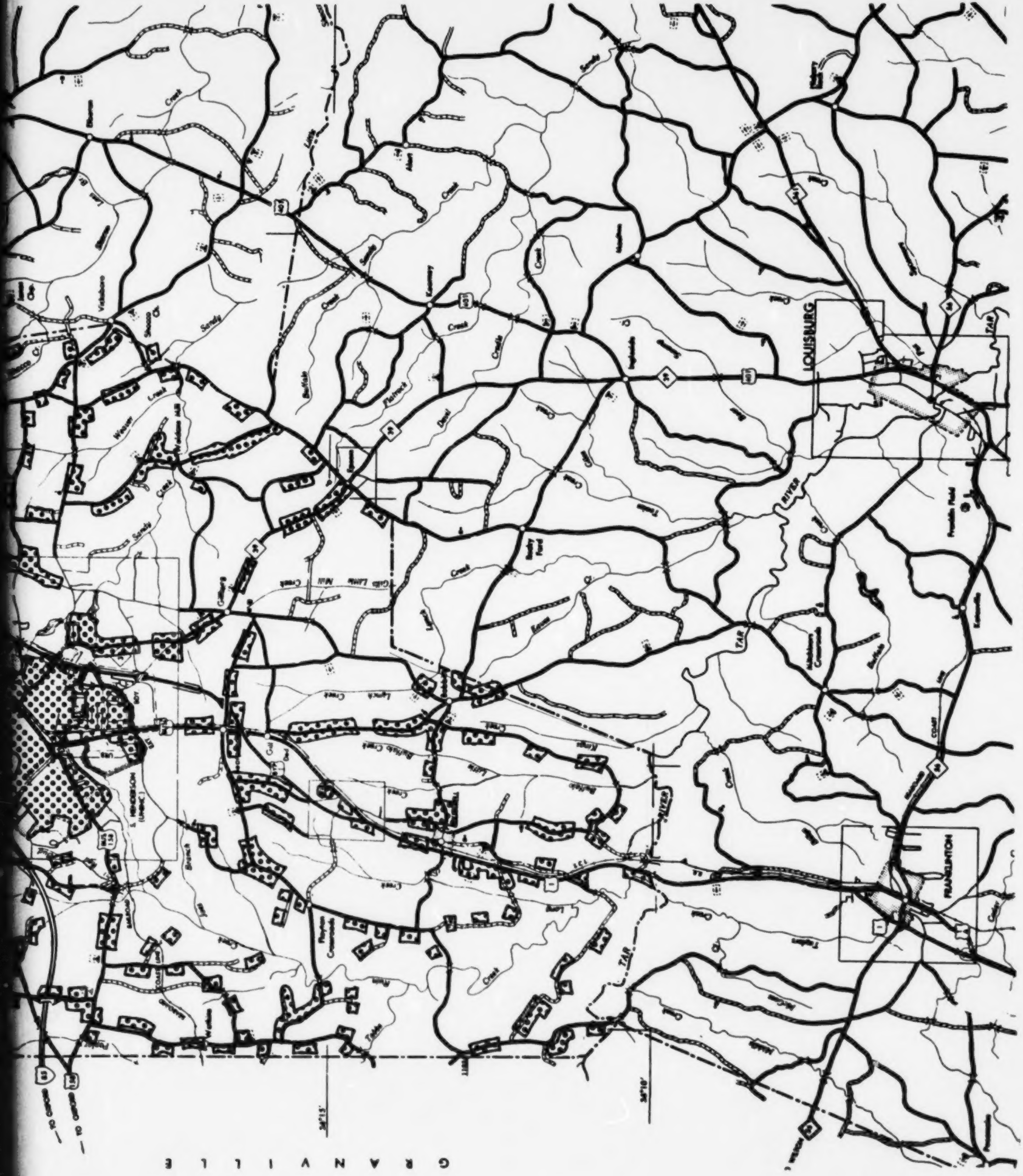
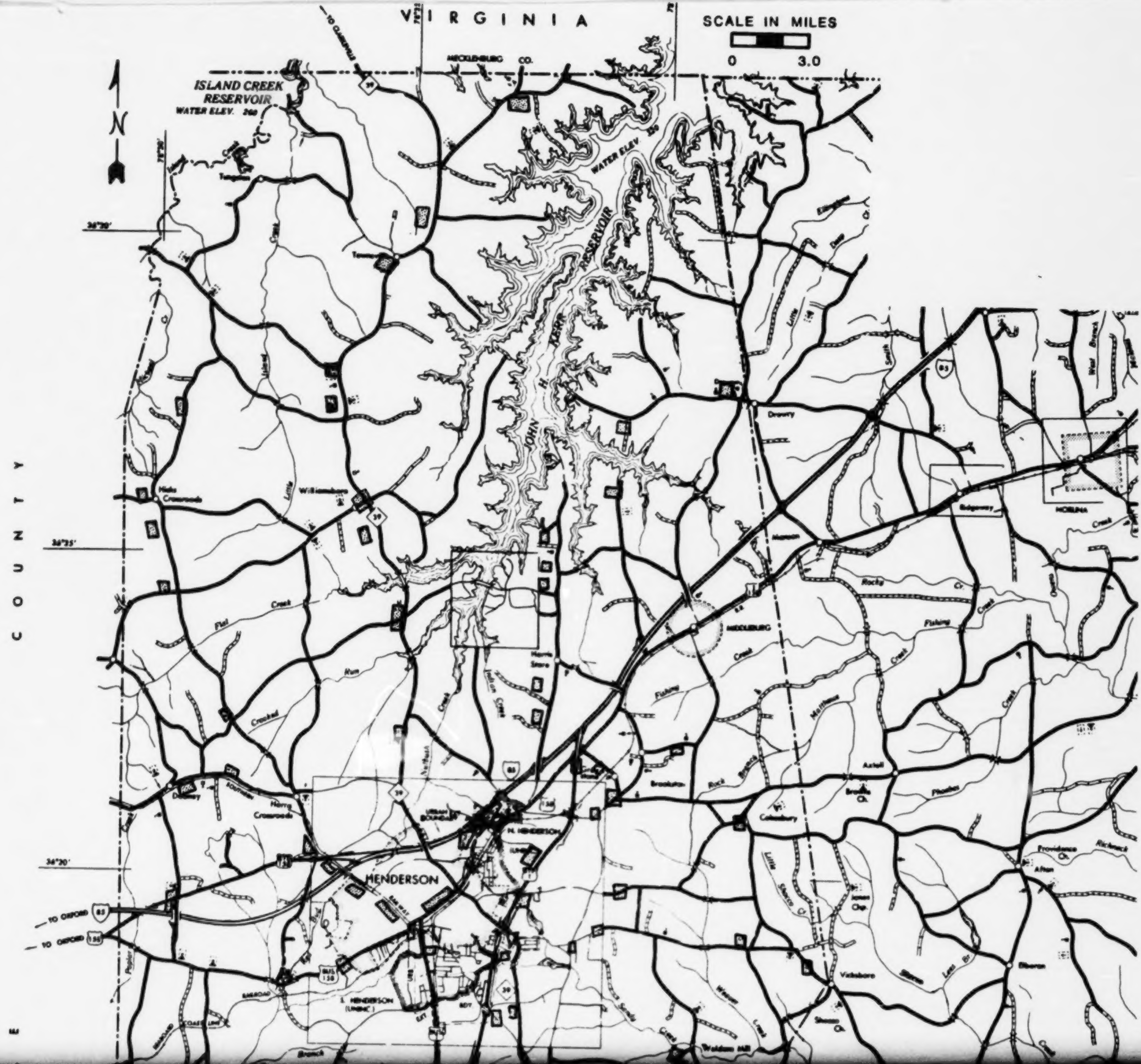

LOUISBURG
FRANKLINTON
HENDERSON
TAR
RIVER
GRANVILLE

FIGURE II-18

LAND USE (GENERALIZED RESIDENTIAL)


VIRGINIA
SCALE IN MILES
0
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MECKLENBURG CO.
ISLAND CREEK RESERVOIR
WATER ELEV. 260
JOHN H. KERR RESERVOIR
WATER ELEV.
TO CLARKSVILLE
COUNTY
36°30'
36°25'
36°20'
Townsville
Drewry
Ridgeway
NORLINA
Hicks Crossroads
Williamsboro
Little
Flat Creek
Run
Crooked
Rocky Cr.
Fishing Creek
Middleburg
Harris Store
Indian Creek
Nutbush
Brookston
Rock Branch
Mathews
Astell
Bearpond
Gillburg
Dabney
Harris Crossroads
HENDERSON
N. HENDERSON
URBAN BOUNDARY
S. HENDERSON
Little Shocco Cr.
Jones Chp.
Vicksboro
Shocco Cr.
Providence Ch.
Alton
Richneck
Elberon
Sandy Creek
Warren
Weldon Mill
Branch
TO OXFORD
85
158
39
1
BUS. 158
SEABOARD
COAST LINE
SOUTHERN
West Branch
Smith
Poplar

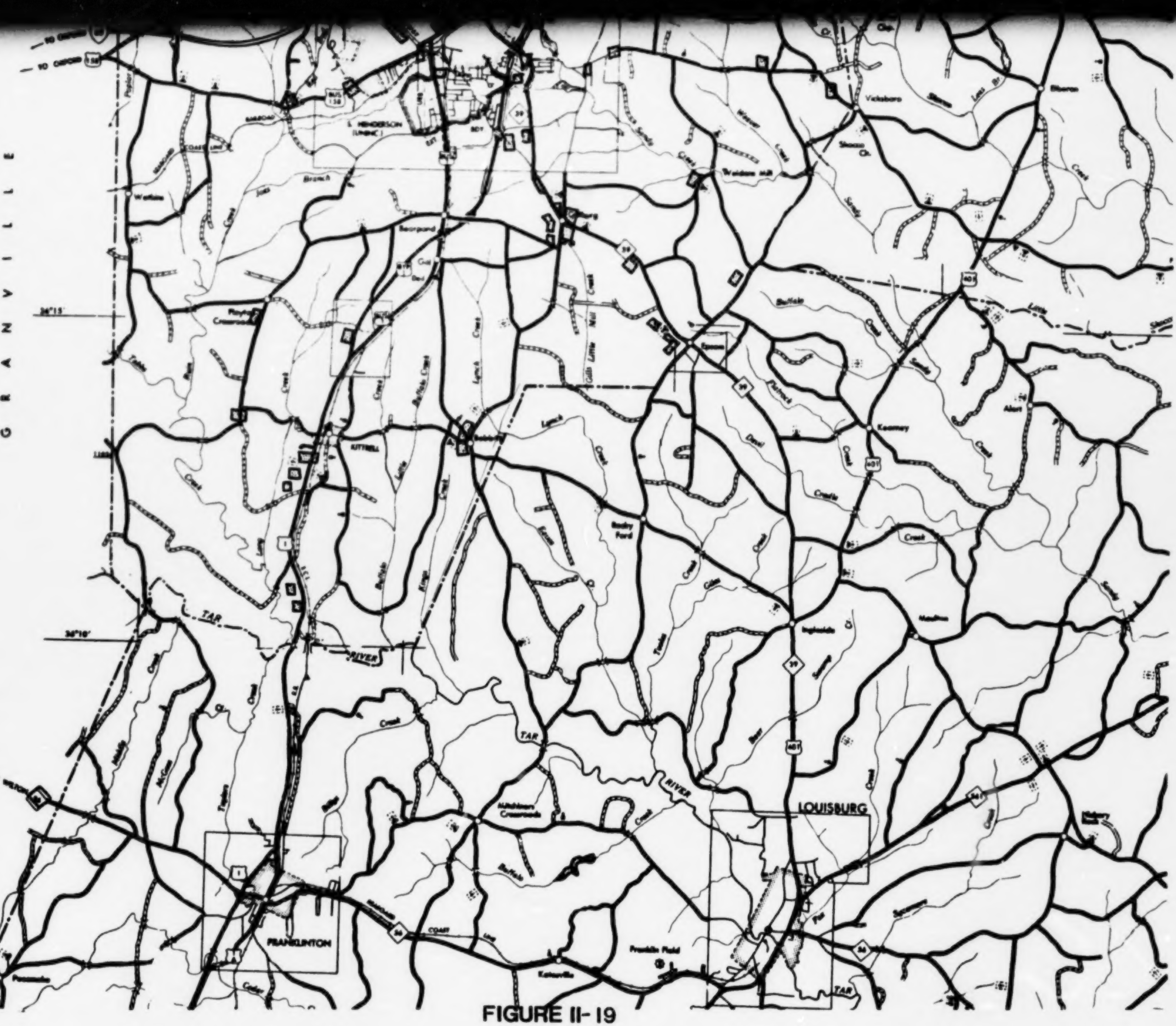
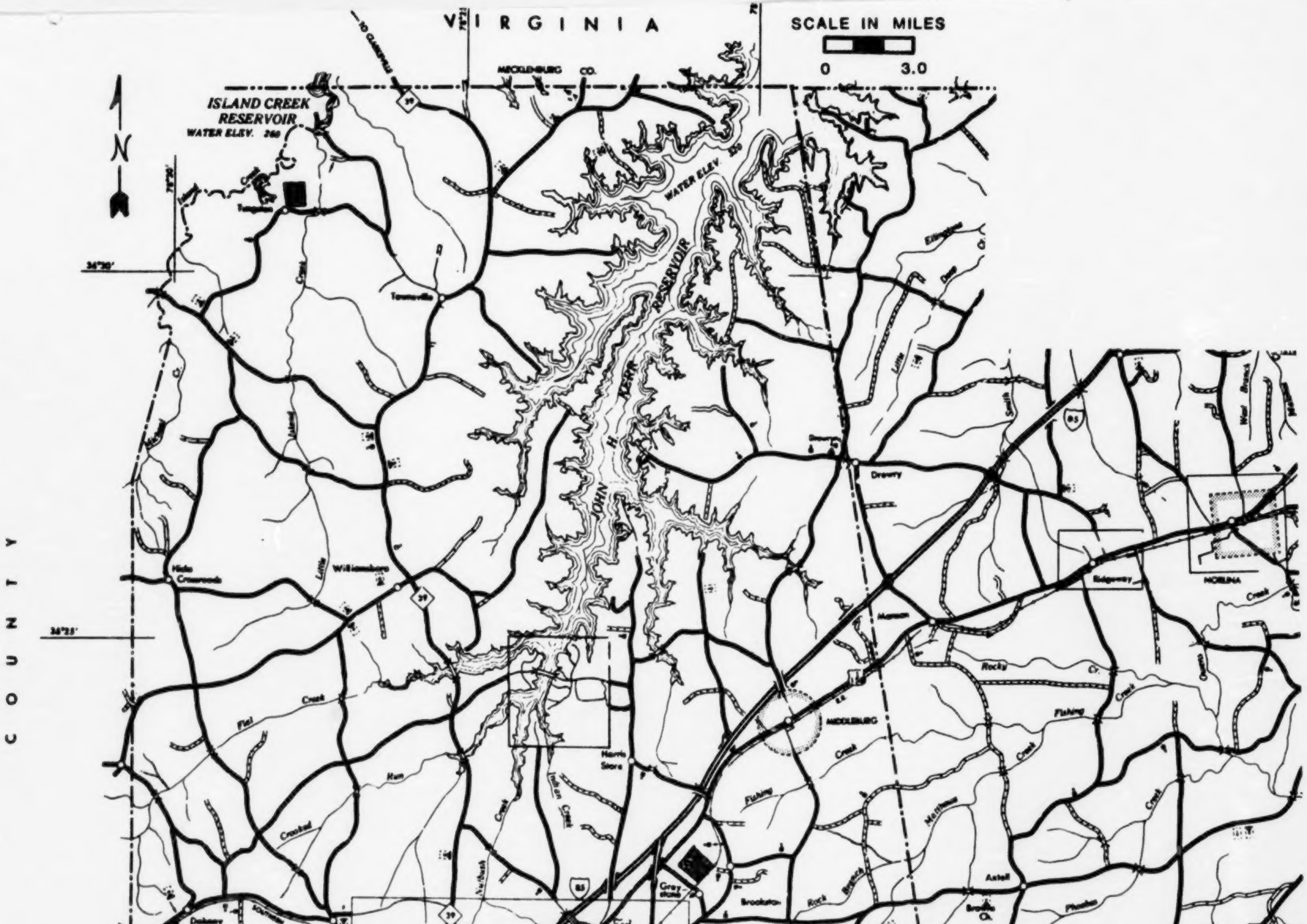

GRANVILLE
TO OXFORD
HENDERSON (UNINC.)
Vicksboro
KITTRELL
Epsom
Kearney
Ingleside
Bunn
TAR
RIVER
LOUISBURG
FRANKLINTON
Franklin Field
Youngsville
Pocomoke
36°15'
36°10'

FIGURE II-19

LAND USE (COMMERCIAL)


VIRGINIA
SCALE IN MILES
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MECKLENBURG CO.
ISLAND CREEK RESERVOIR
WATER ELEV. 260
JOHN H. KERR RESERVOIR
WATER ELEV.
Townsville
Williamsboro
Nutbush Crossroads
Drewry
Manson
Ridgeway
NORLINA
MIDDLEBURG
Harris Store
Gray Rock
Brookston
Dabney
Harris Crossroads
N. HENDERSON
(UNINC.)
URBAN BOUNDARY
HENDERSON
S. HENDERSON
(UNINC.)
Cokesbury
Astell
Afton
Vicksboro
Elberon
Shocco Ch.
Little Shocco Cr.
Rocky Cr.
Fishing Creek
Flat Creek
Crooked Run
Nutbush Creek
Indian Creek
Sandy Creek
Weaver Creek
Matthews
TO OXFORD
TO CLARKSVILLE
85
39
1
158
BUS 158
36°30'
36°25'
36°20'
COUNTY

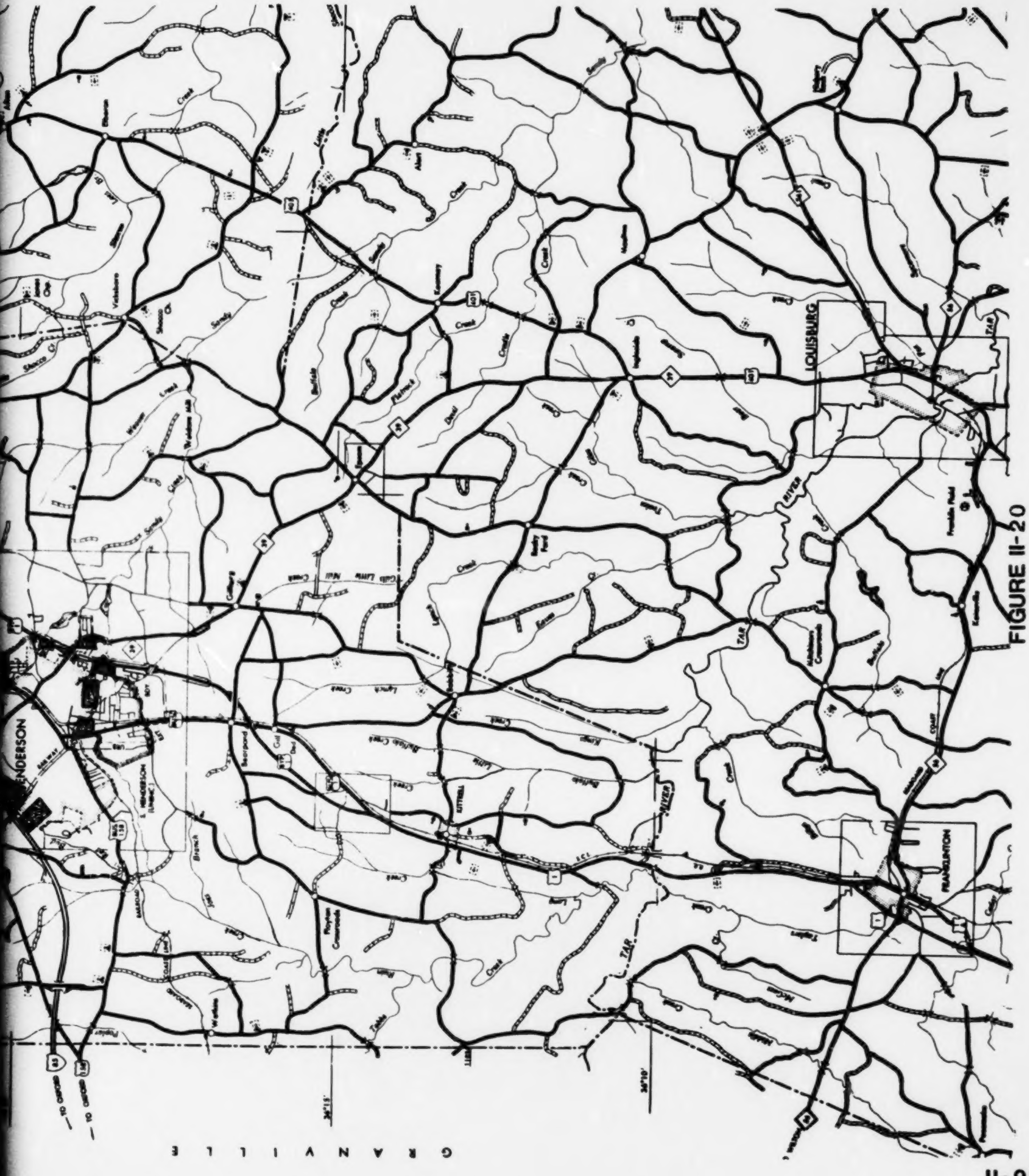
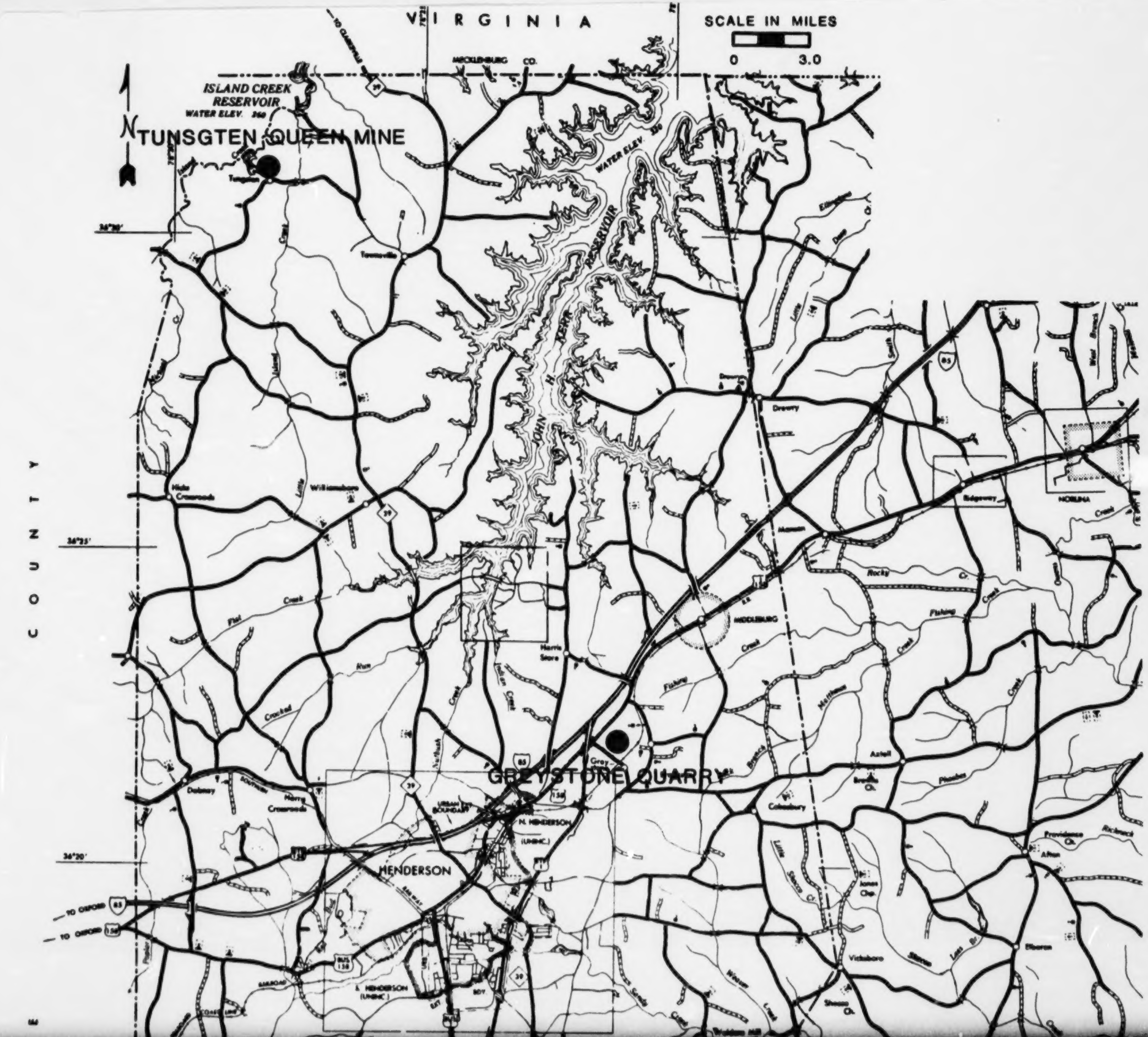

HENDERSON
LOUISBURG
FRANKLINTON
TAR RIVER
GRANVILLE
TO OXFORD
TO OXFORD
Franklin Field
Kittrell
Sandy Creek
Shocco Cr.
Lynch Creek

FIGURE II-20

LAND USE (INDUSTRIAL)


VIRGINIA
SCALE IN MILES
0
3.0
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MECKLENBURG CO.
ISLAND CREEK RESERVOIR
WATER ELEV. 260
TUNSGTEN QUEEN MINE
Tungsten
Townsville
JOHN H. KERR RESERVOIR
WATER ELEV. 300
Drewry
Ridgeway
NORLINA
Manson
Rocky Cr.
Fishing Creek
MIDDLEBURG
Harris Store
Hicks Crossroads
Williamsboro
Flat Creek
Crooked Run
GREYSTONE QUARRY
Grey-stone
Nutbush Creek
Indian Creek
Dabney
Harris Crossroads
N. HENDERSON (UNINC.)
HENDERSON
S. HENDERSON (UNINC.)
RAILROAD
— TO OXFORD
— TO OXFORD
Cokesbury
Brodie Ch.
Axtell
Phoebus
Little Shocco Cr.
Jones Chp.
Vicksboro
Shocco Ch.
Shocco
Epsom
Afton
Providence Ch.
Richneck
Waldon Mill
Sandy Creek
Matthews
Little Grassy Creek
Smith Creek
36°30'
36°25'
36°20'
COUNTY
39
85
158
1
E

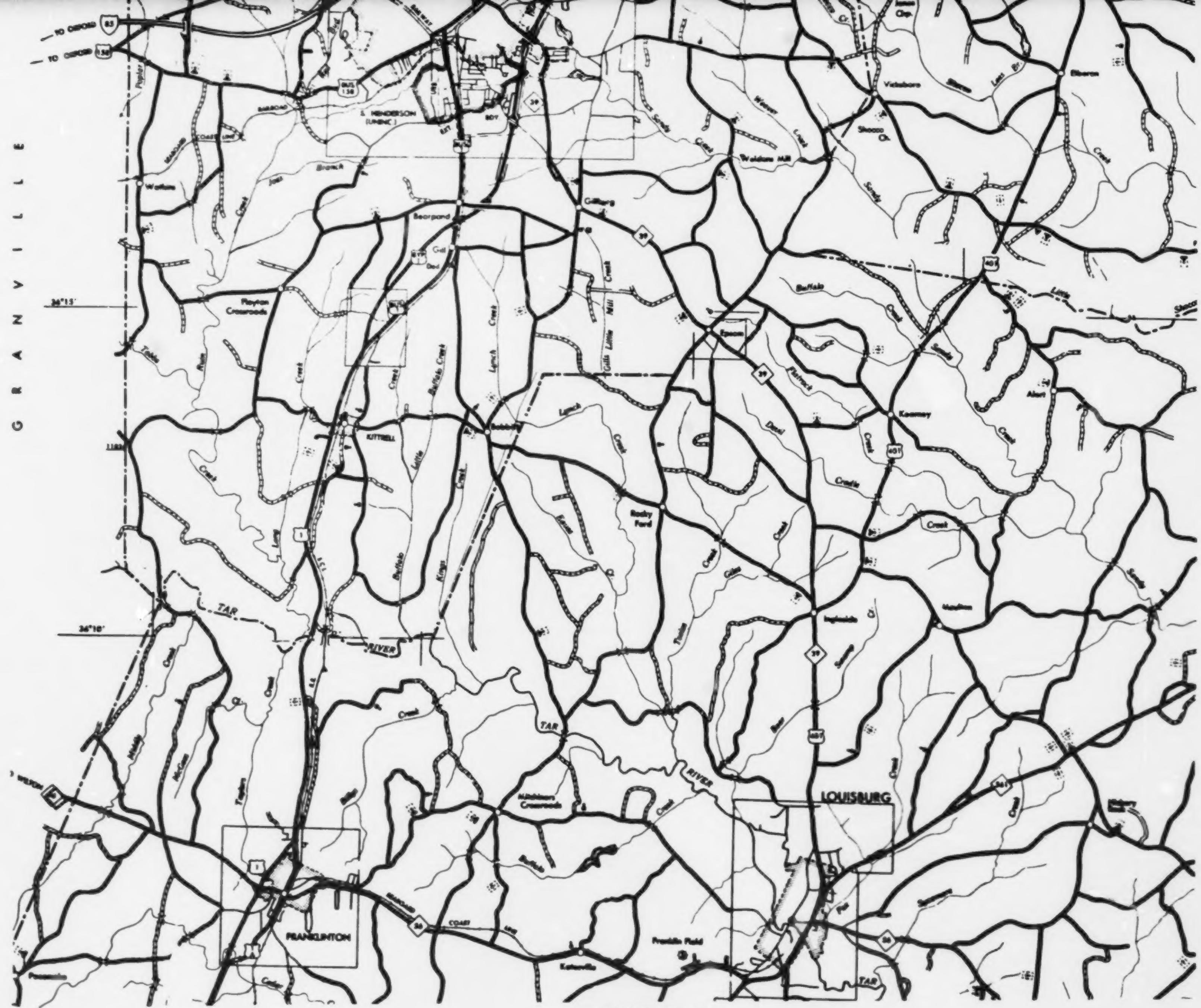
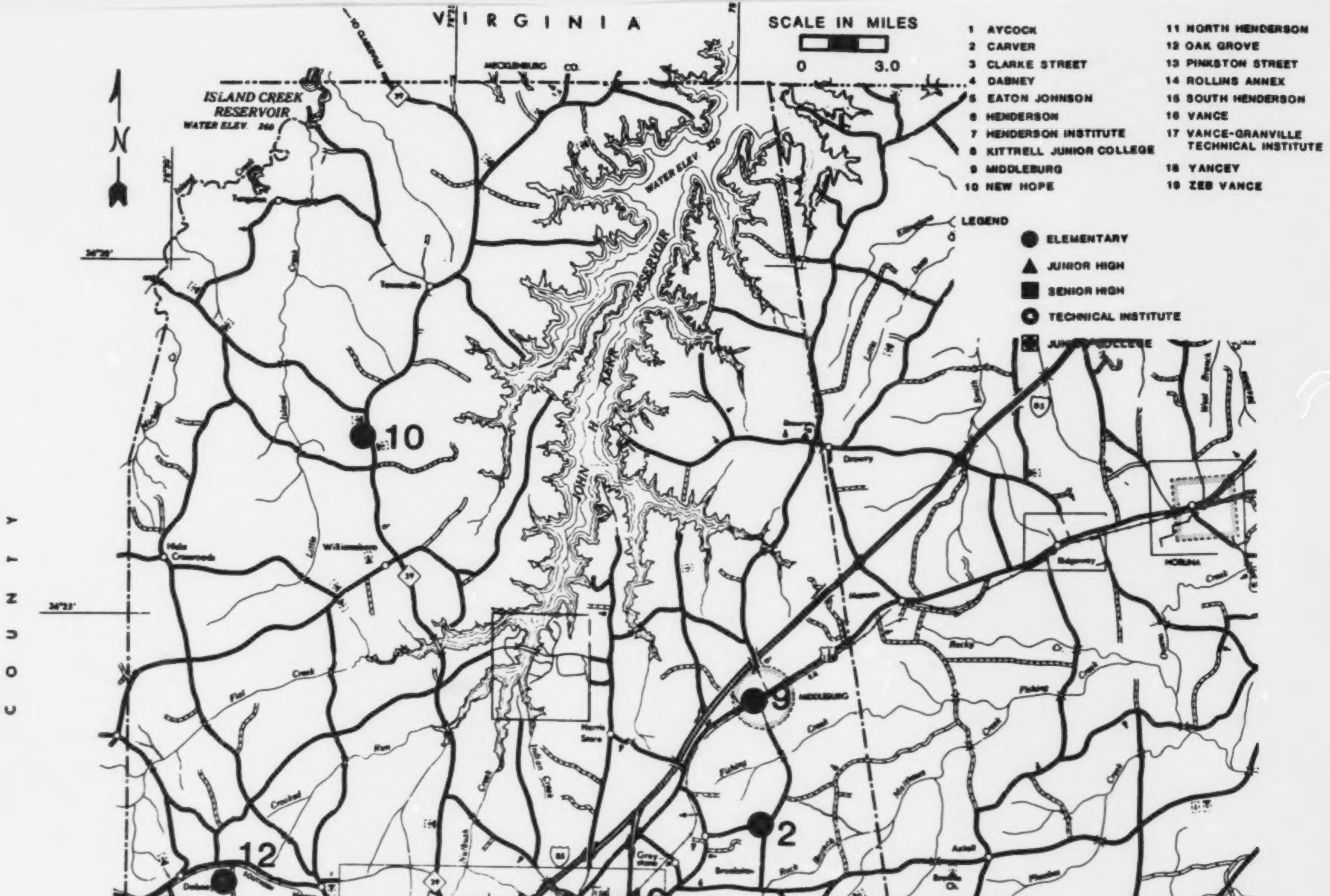

GRANVILLE
TO OXFORD
TO OXFORD
HENDERSON (UNINC.)
Watkins
Gillburg
Bearpond
Peyton Crossroads
36°15'
KITTRELL
Epsom
Kearney
Vicksboro
Shocco Cr.
Rocky Ford
Ingleside
36°10'
TAR
RIVER
TAR
RIVER
Mitchiners Crossroads
LOUISBURG
FRANKLINTON
Franklin Field
Katesville
TO WILTON
Lynch Creek
Buffalo Creek
Sandy Creek
Cedar Creek
TAR

FIGURE II-21

LAND USE (EXTRACTIVE)


VIRGINIA
SCALE IN MILES
0
3.0
1 AYCOCK
2 CARVER
3 CLARKE STREET
4 DABNEY
5 EATON JOHNSON
6 HENDERSON
7 HENDERSON INSTITUTE
8 KITTRELL JUNIOR COLLEGE
9 MIDDLEBURG
10 NEW HOPE
11 NORTH HENDERSON
12 OAK GROVE
13 PINKSTON STREET
14 ROLLINS ANNEX
15 SOUTH HENDERSON
16 VANCE
17 VANCE-GRANVILLE TECHNICAL INSTITUTE
18 YANCEY
19 ZEB VANCE
LEGEND
● ELEMENTARY
▲ JUNIOR HIGH
■ SENIOR HIGH
○ TECHNICAL INSTITUTE
▨ JUNIOR COLLEGE
N
ISLAND CREEK RESERVOIR
WATER ELEV. 260
MECKLENBURG CO.
JOHN H. KERR RESERVOIR
WATER ELEV.
HENDERSON
MIDDLEBURG
NORLINA
TO OXFORD
TO OXFORD
COUNTY
10
12
4
9
2
16
11
13
17
14
6
1
3
15
18
Fishing Creek
Little Shocco Cr.
Indian Creek
Flat Creek

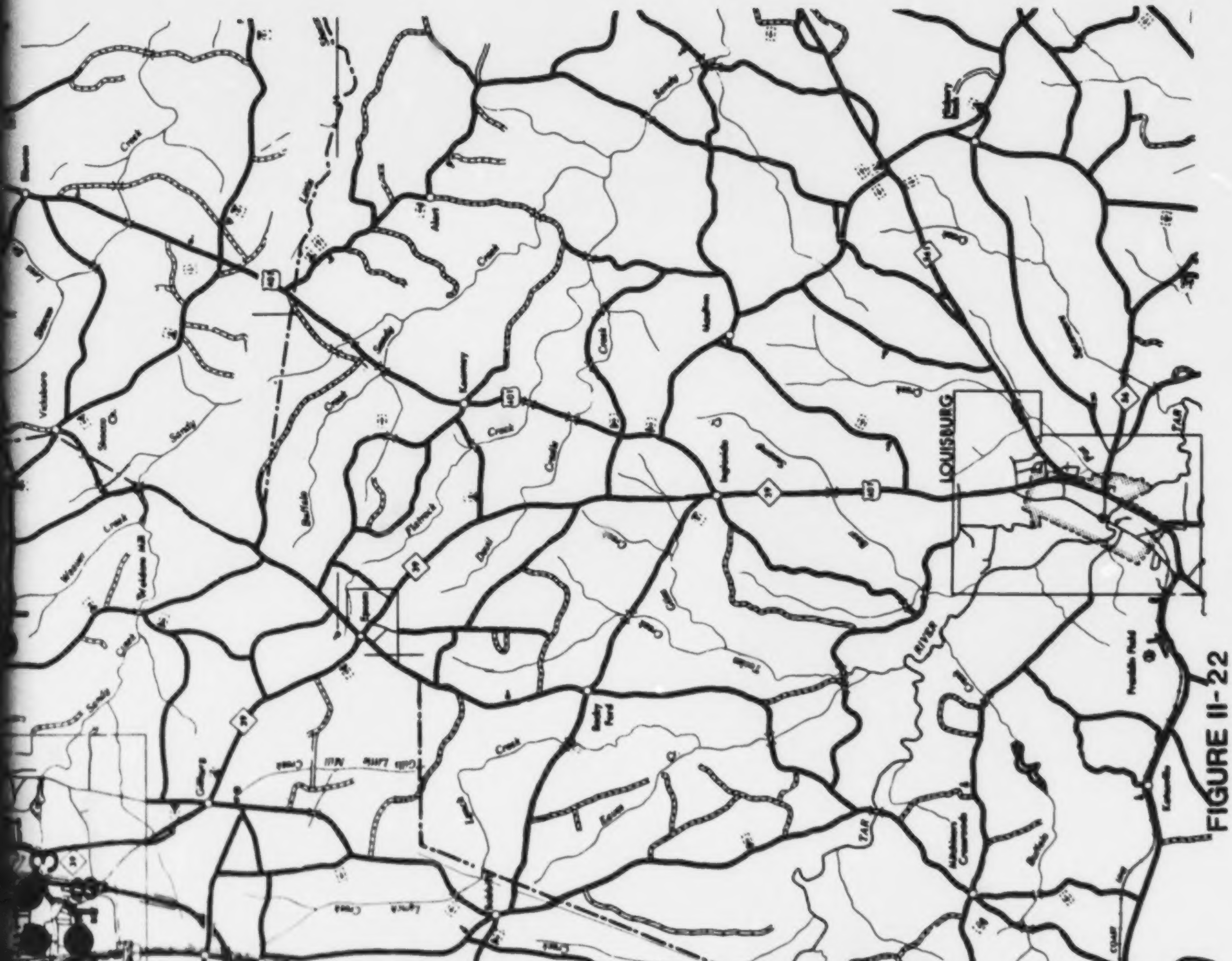
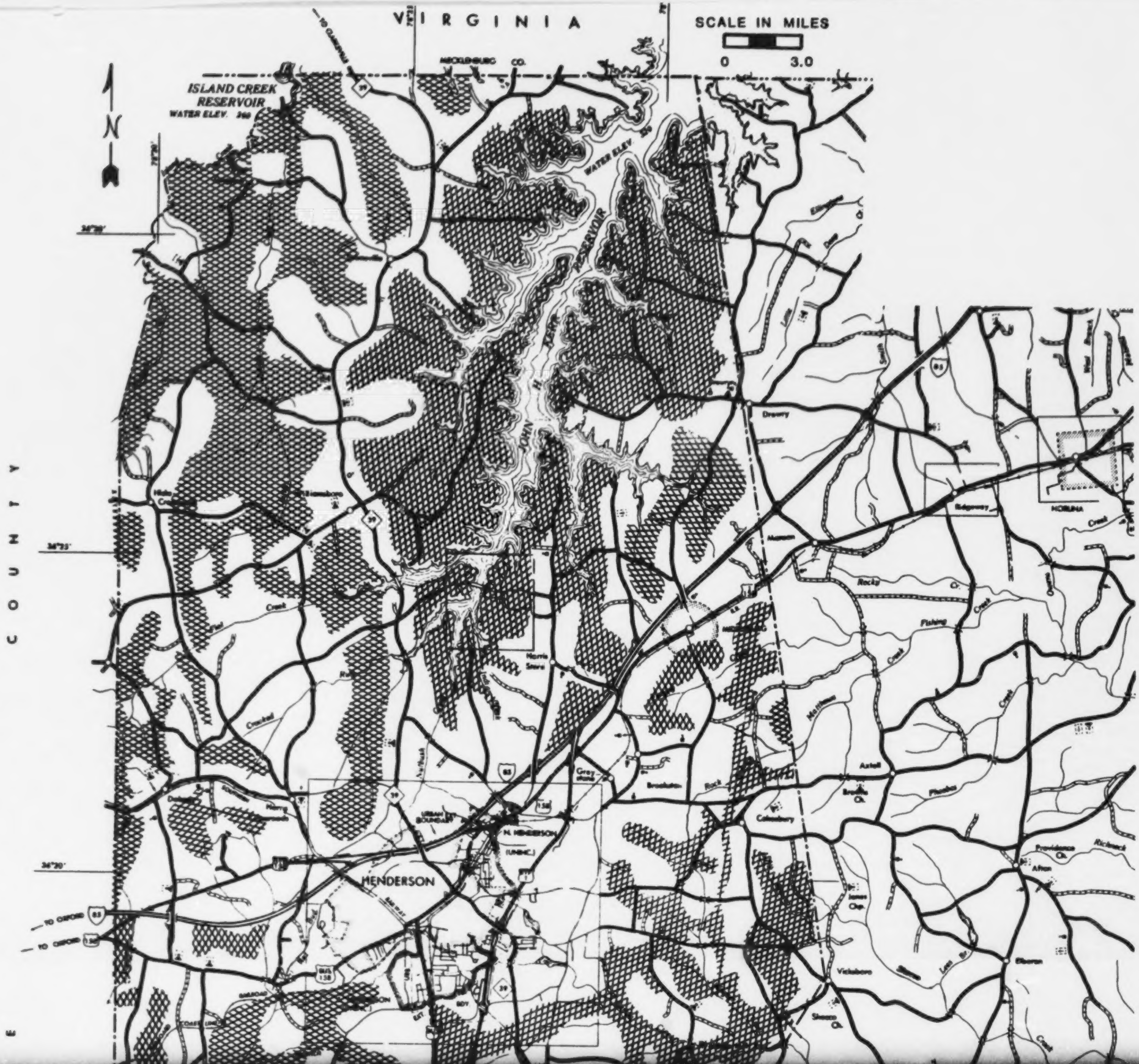
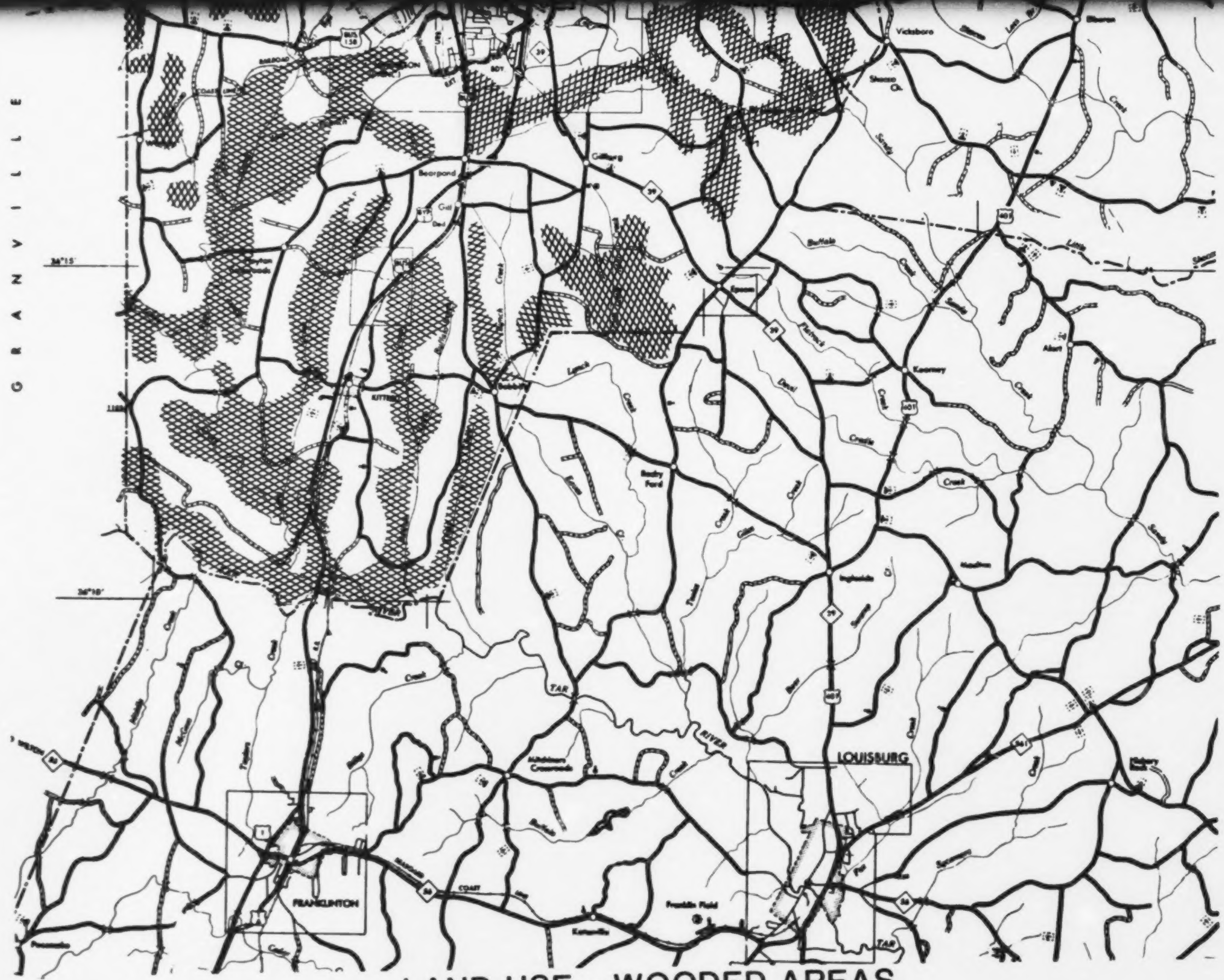

LOUISBURG
FRANKLINTON
KITTRELL
TAR RIVER
19
8
GRANVILLE

FIGURE II-22

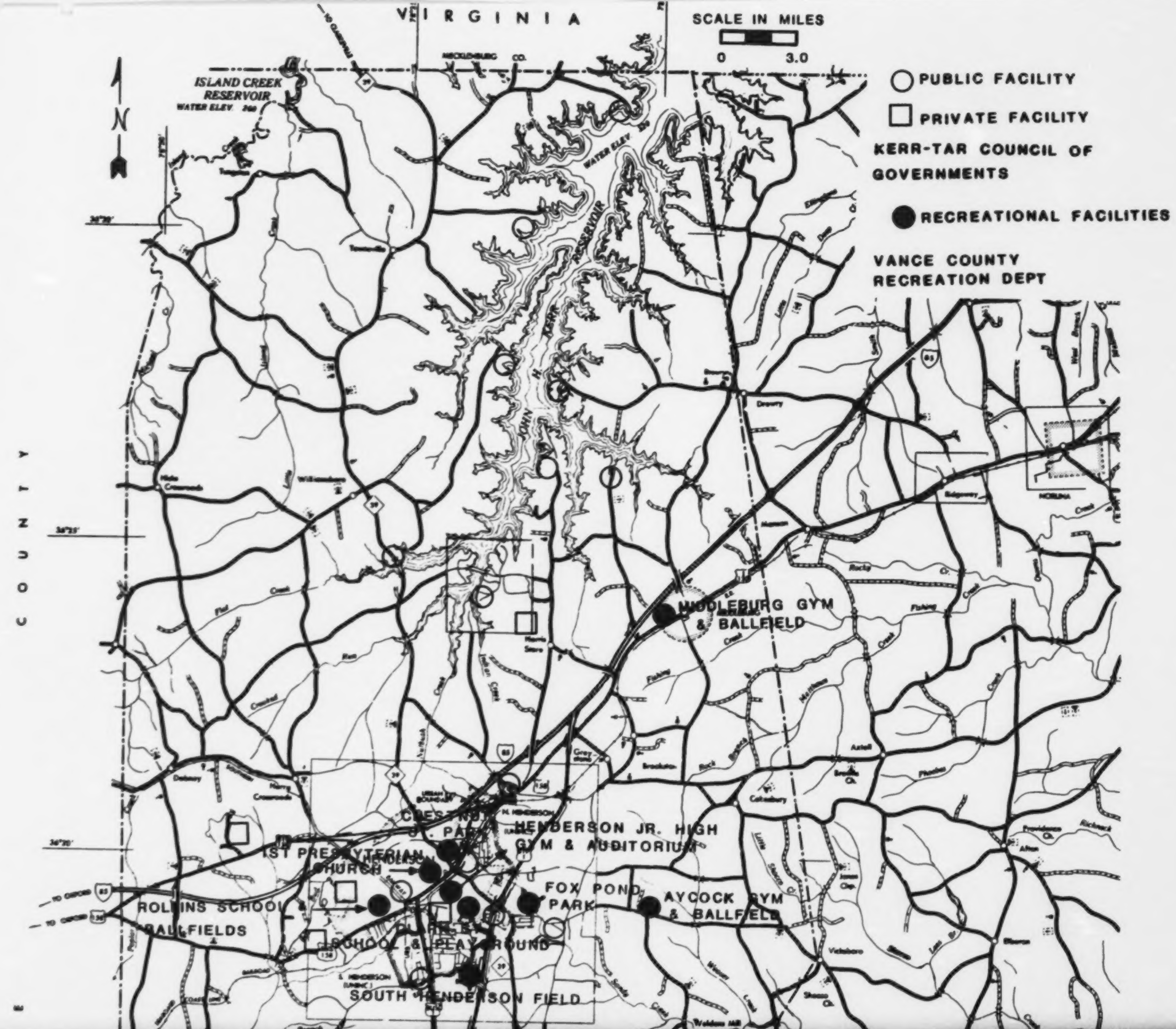
LAND USE (INSTITUTIONAL)


VIRGINIA
SCALE IN MILES
0
3.0
N
MECKLENBURG CO.
ISLAND CREEK RESERVOIR
WATER ELEV. 260
JOHN H. KERR RESERVOIR
WATER ELEV.
TO CLARKSVILLE
COUNTY
Drewry
Ridgeway
NORLINA
Manson
Rocky Cr.
Fishing Creek
Harris Store
Middleburg
Williamsboro
Gupton
Greystone
Brookston
Astatula
Brodie Ch.
Cokesbury
Henderson
N. HENDERSON (UNINC.)
URBAN AREA BOUNDARY
HENDERSON
TO OXFORD
Dabney
Kittrell
Vicksboro
Afton
Elberon
Providence Ch.
Sleepy Cr.
Jones Chp.
36°20'
36°25'
36°30'
78°30'
78°25'
78°20'


GRANVILLE
LOUISBURG
FRANKLINTON
TAR
RIVER
Vicksboro
Bearpond
Gillburg
Kittrell
Ingleside
Kearney
Sandy Creek
Franklin Field
Kenzelle
Hickory Rock
Middleburg Crossroads
36°15'
36°10'

LAND USE - WOODED AREAS

FIGURE II- 23


VIRGINIA
SCALE IN MILES
0
3.0
○ PUBLIC FACILITY
□ PRIVATE FACILITY
KERR-TAR COUNCIL OF GOVERNMENTS
● RECREATIONAL FACILITIES
VANCE COUNTY RECREATION DEPT
N
ISLAND CREEK RESERVOIR
WATER ELEV. 260
MECKLENBURG CO.
JOHN H. KERR RESERVOIR
COUNTY
MIDDLEBURG GYM & BALLFIELD
HENDERSON JR. HIGH GYM & AUDITORIUM
CHESTNUT ST. PARK
1ST PRESBYTERIAN CHURCH
FOX POND PARK
AYCOCK GYM & BALLFIELD
ROLLINS SCHOOL & BALLFIELDS
PEACE SCHOOL & PLAYGROUND
SOUTH HENDERSON FIELD
NORLINA
TO OXFORD
TO OXFORD

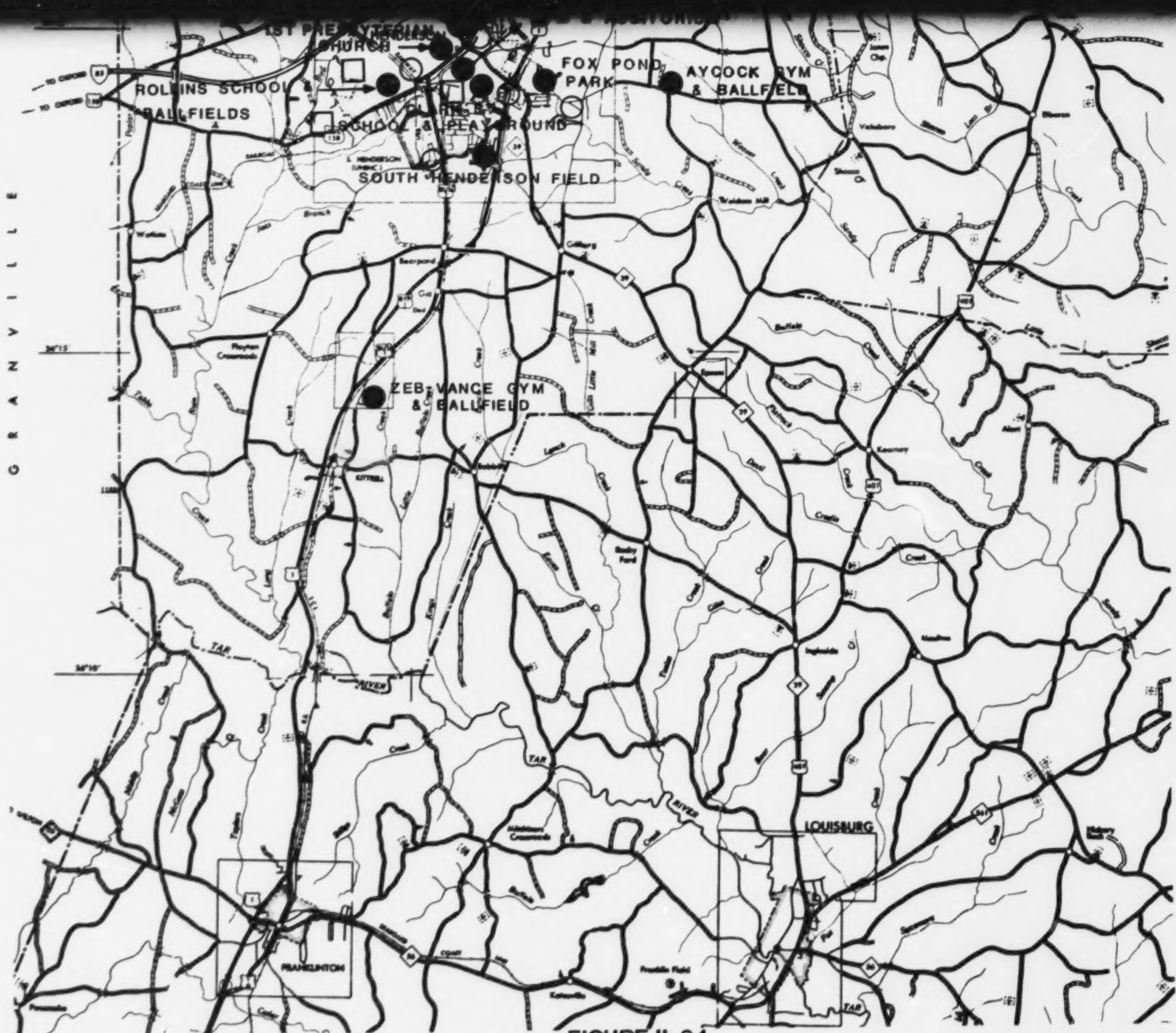
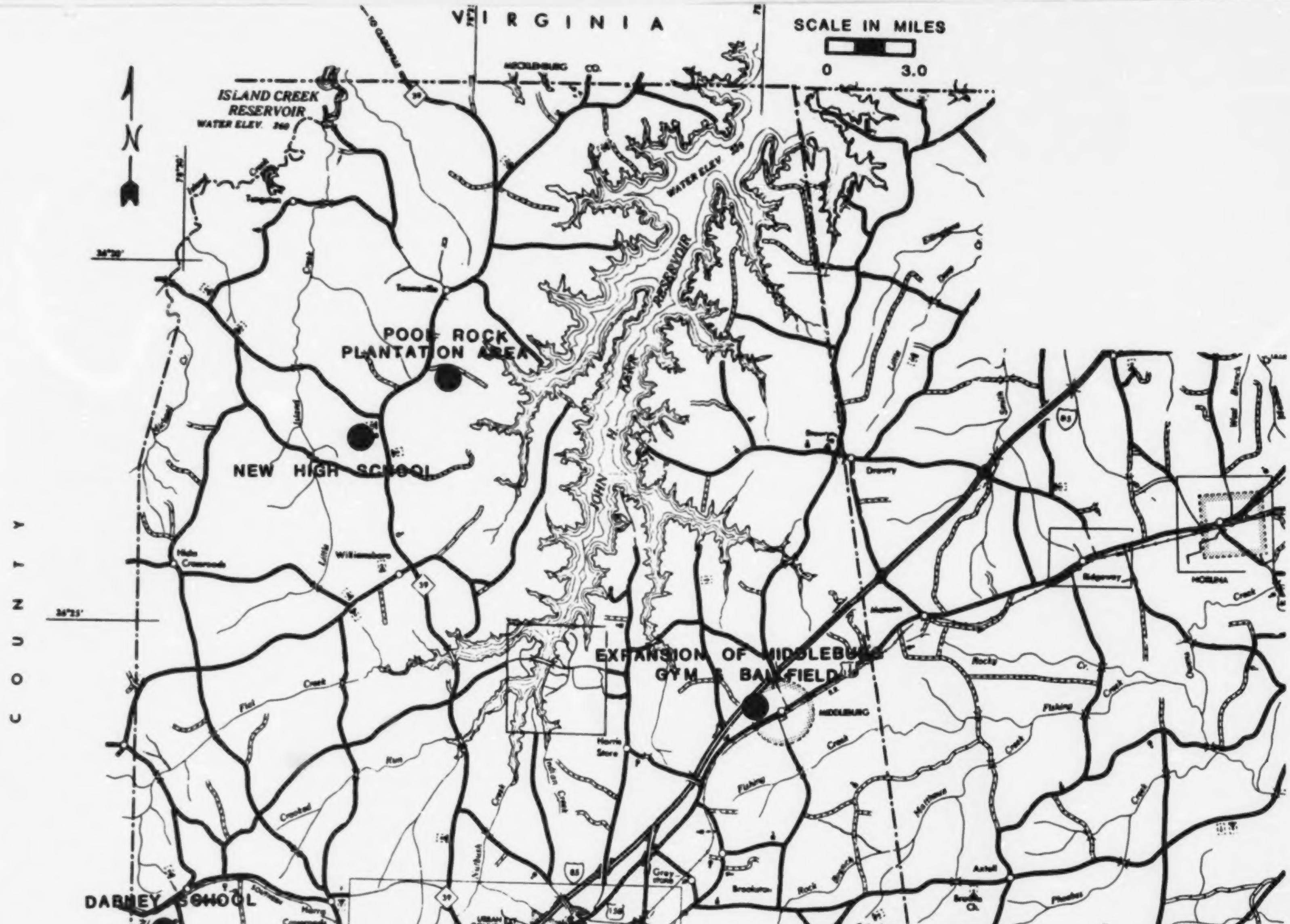

1ST PRESBYTERIAN CHURCH
ROLLINS SCHOOL & BALLFIELDS
SCHOOL & PLAYGROUND
FOX POND PARK
AYCOCK GYM & BALLFIELD
SOUTH HENDERSON FIELD
ZEB VANCE GYM & BALLFIELD
GRANVILLE
TAR
RIVER
LOUISBURG
FRANKLINTON
KITTRELL
TO OXFORD
TO OXFORD

FIGURE II-24

RECREATIONAL FACILITIES


VIRGINIA
SCALE IN MILES
0
3.0
N
ISLAND CREEK RESERVOIR
WATER ELEV. 260
MECKLENBURG CO.
JOHN H. KERR RESERVOIR
WATER ELEV.
POOL ROCK PLANTATION AREA
NEW HIGH SCHOOL
EXPANSION OF MIDDLEBURG GYM & BALLFIELD
MIDDLEBURG
DABNEY SCHOOL
HENDERSON
N. HENDERSON
EXPANSION OF AYCOCK GYM & BALLFIELD
FLINT HILL NEIGHBORHOOD RECREATIONAL AREA
S. HENDERSON
NORLINA
Ridgeway
Drewry
Townsville
Williamsboro
Harris Store
Gray Rock
Brookston
Cokesbury
Vicksboro
Afton
Elberon
Flat Creek
Rocky Cr.
Fishing Creek
Indian Creek
Little Sandy Creek
Shocco Cr.
TO OXFORD
TO OXFORD
TO CLARKSVILLE
36°30'
36°25'
36°20'
COUNTY

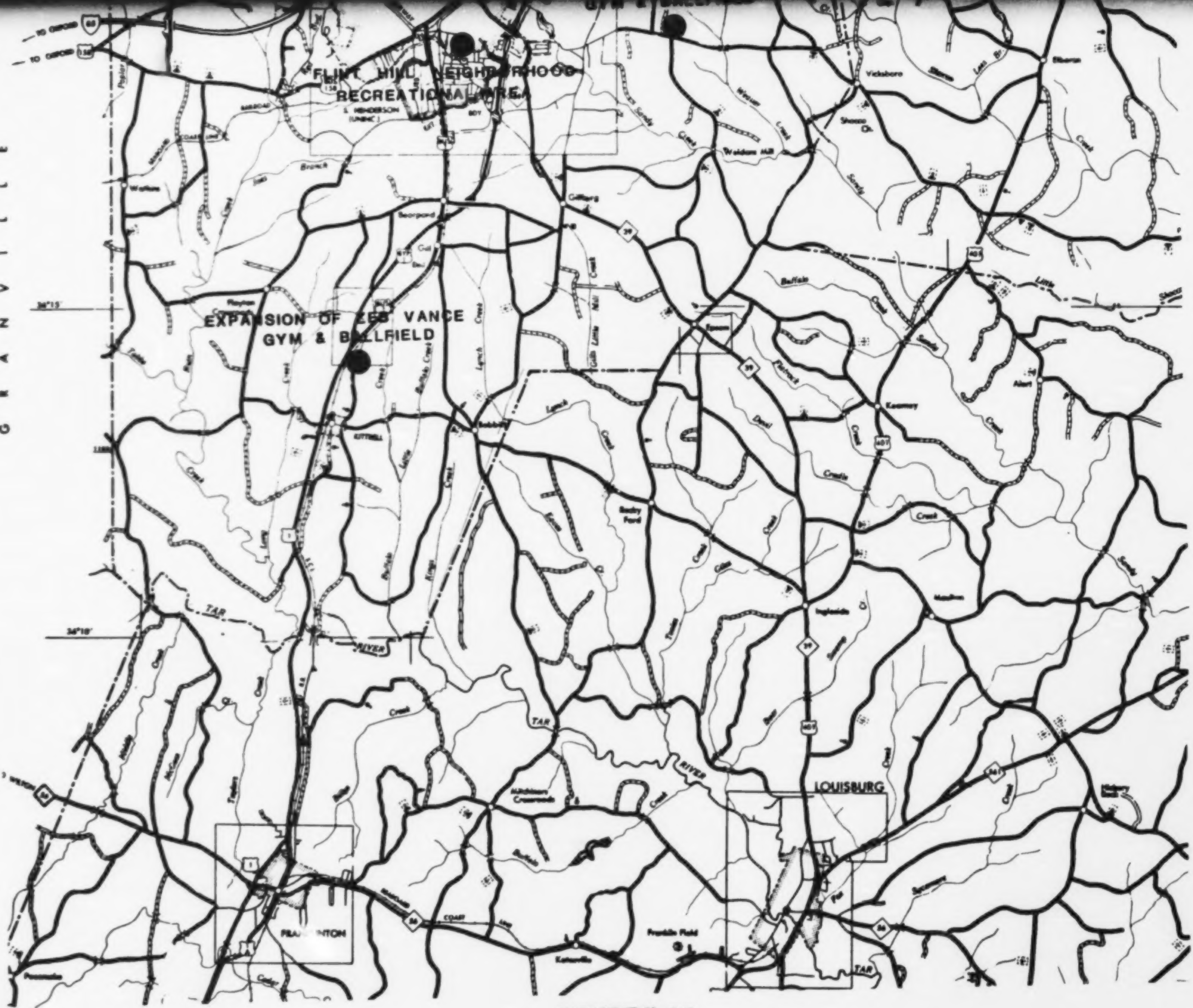
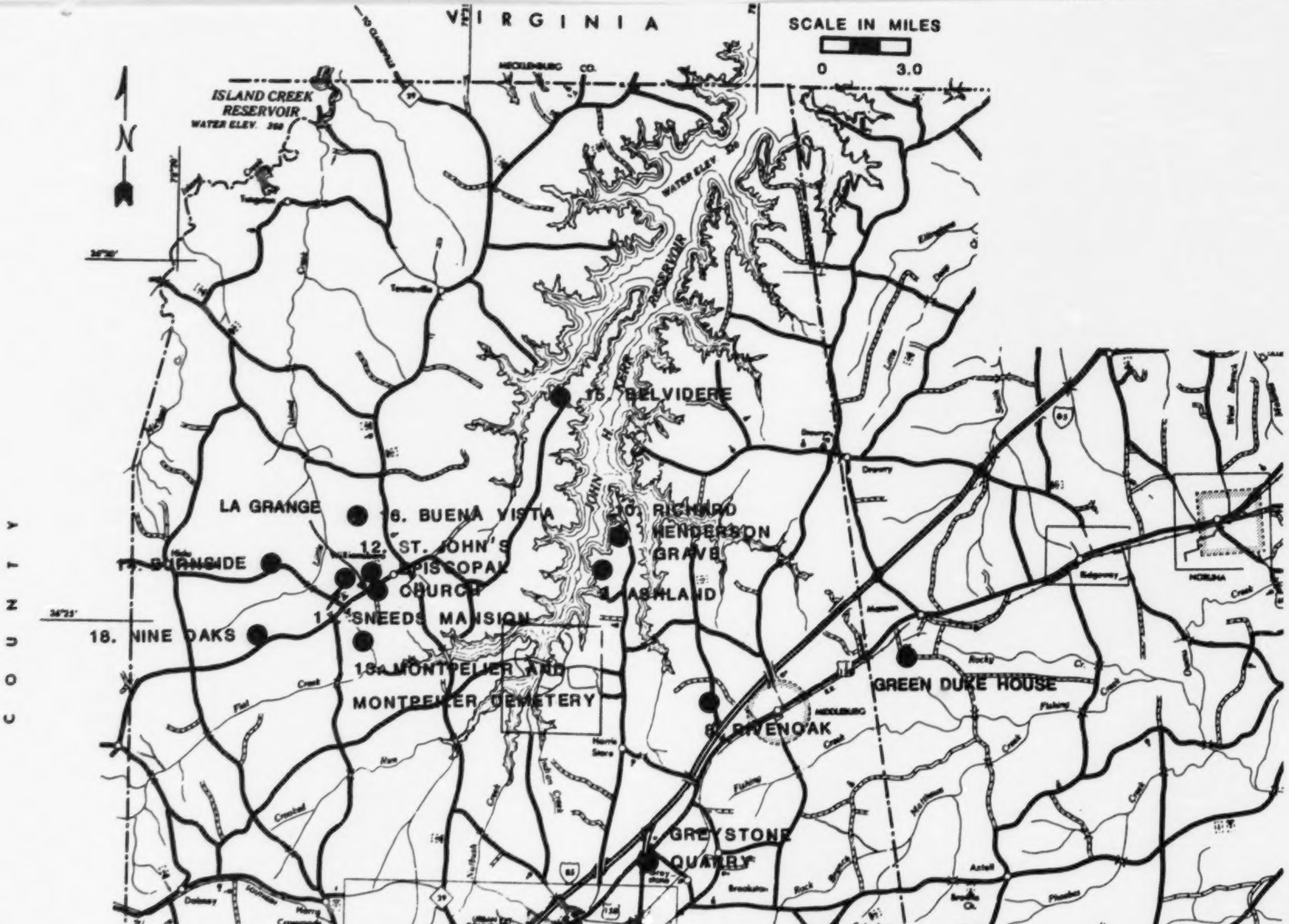

FLINT HILL NEIGHBORHOOD RECREATIONAL AREA
EXPANSION OF ZEB VANCE GYM & BALLFIELD
G R A N V I L L E
TO OXFORD
HENDERSON
LOUISBURG
FRANKLINTON
TAR
RIVER
Vicksboro
Kearney
Ingleside
Bobbitt
Kittrell
Gillburg
Epsom
Franklin Field
Youngsville
36°15'
36°10'

FIGURE II-25

PROPOSED RECREATIONAL FACILITIES


VIRGINIA
SCALE IN MILES
0
3.0
N
MECKLENBURG CO.
ISLAND CREEK RESERVOIR
WATER ELEV. 260
JOHN H. KERR RESERVOIR
WATER ELEV.
TO CLARKSVILLE
Townsville
15. BELVIDERE
LA GRANGE
16. BUENA VISTA
10. RICHARD HENDERSON GRAVE
12. ST. JOHN'S EPISCOPAL CHURCH
17. BURNSIDE
1. ASHLAND
SNEEDS MANSION
18. NINE OAKS
13. MONTPELIER AND MONTPELIER CEMETERY
GREEN DUKE HOUSE
RIVENOAK
MIDDLEBURG
Drewry
Manson
Norlina
GREYSTONE QUARRY
ELMWOOD
CEMETERY
HENDERSON
N. HENDERSON
U.S. POST OFFICE
2. LOCUST HILL
6. D.W. WELDON
HILL
Dabney
Harris Crossroads
Brookston
Kittrell
Vicksboro
Afton
Epsom
TO OXFORD
34°25'
34°20'
COUNTY
E

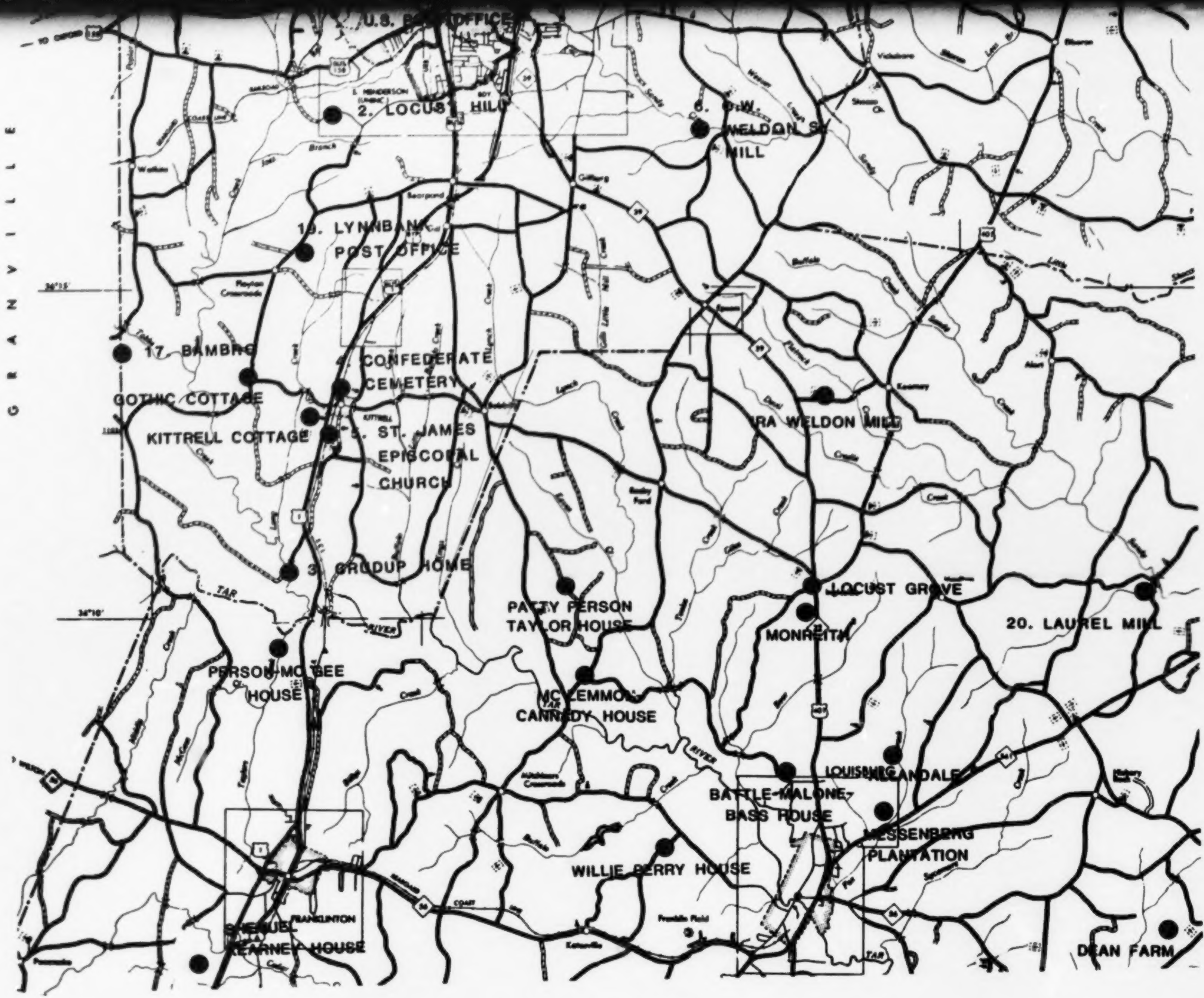
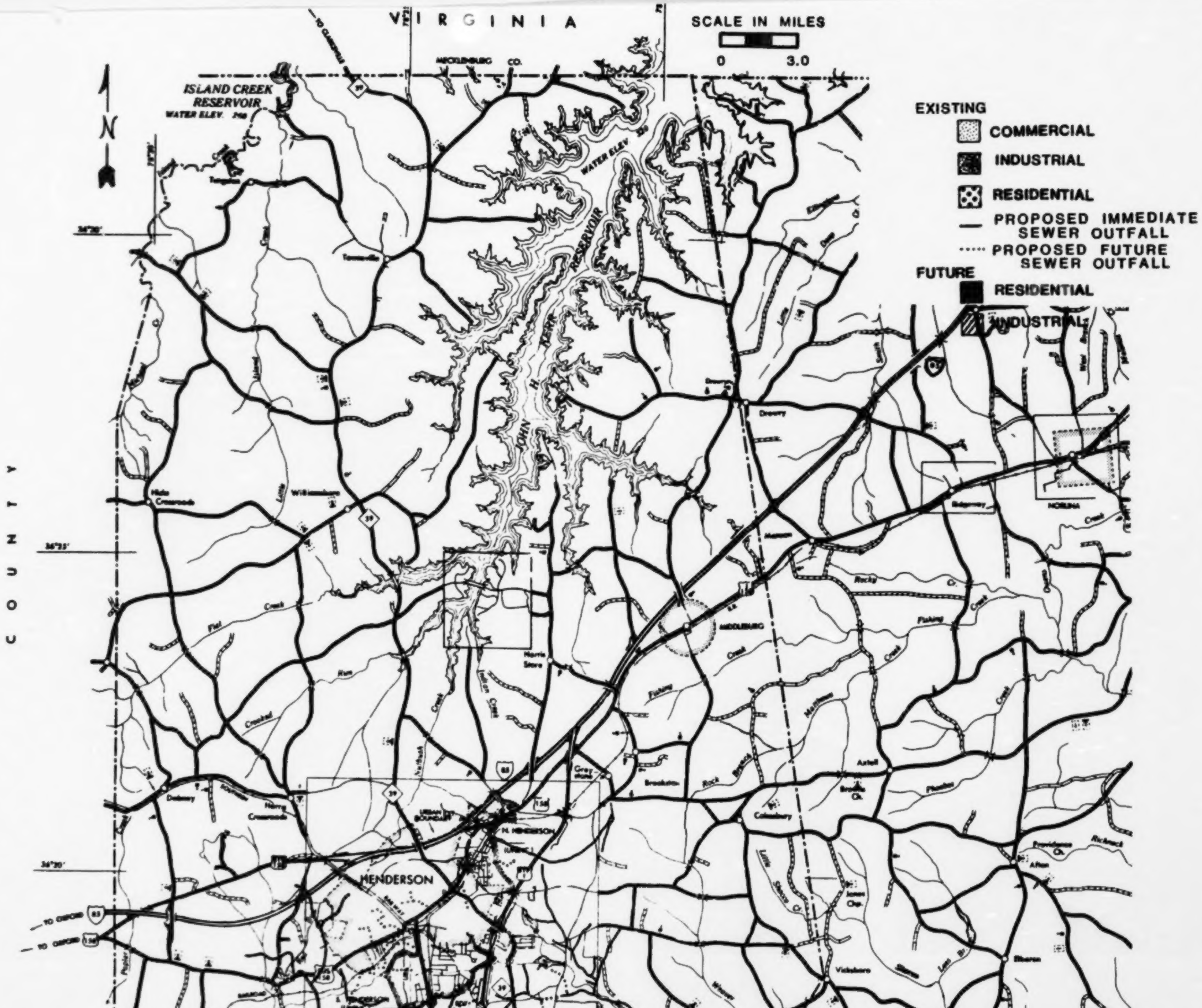
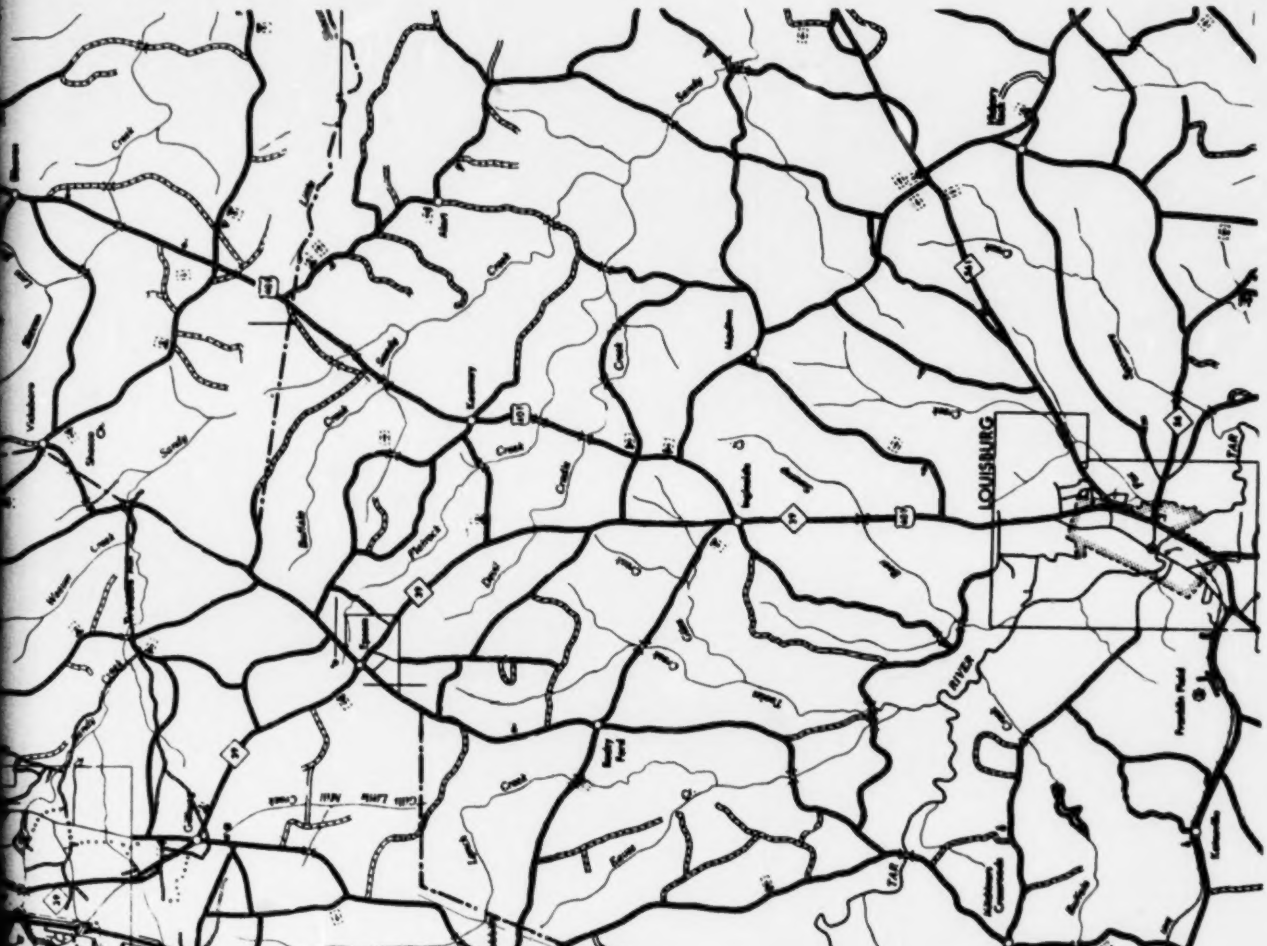

U.S. POST OFFICE
2. LOCUST HILL
6. O.W. WELDON MILL
19. LYNNBANK POST OFFICE
17. BAMBRG
GOTHIC COTTAGE
4. CONFEDERATE CEMETERY
KITTRELL COTTAGE
5. ST. JAMES EPISCOPAL CHURCH
IRA WELDON MILL
3. CRUDUP HOME
PATTY PERSON TAYLOR HOUSE
LOCUST GROVE
MONREITH
20. LAUREL MILL
PERSON-MCGEE HOUSE
MCLEMMON CANNADY HOUSE
LOUISBURG
BATTLE-MALONE-BASS HOUSE
MESSENBERG PLANTATION
WILLIE PERRY HOUSE
SHEMUEL KEARNEY HOUSE
FRANKLINTON
DEAN FARM
TAR RIVER
KITTRELL
GRANVILLE

FIGURE II-26
HISTORICAL SITES


VIRGINIA
SCALE IN MILES
0
3.0
EXISTING
COMMERCIAL
INDUSTRIAL
RESIDENTIAL
PROPOSED IMMEDIATE SEWER OUTFALL
PROPOSED FUTURE SEWER OUTFALL
FUTURE
RESIDENTIAL
INDUSTRIAL
ISLAND CREEK RESERVOIR
WATER ELEV. 248
MECKLENBURG CO.
JOHN H. KERR RESERVOIR
WATER ELEV.
COUNTY
N
TO OXFORD
TO OXFORD
85
158
39
1
HENDERSON
N. HENDERSON
URBAN BOUNDARY
MIDDLEBURG
NORLINA
Ridgeway
Drewry
Manson
Harris Store
Townsville
Hicks Crossroads
Williamsboro
Dabney
Harris Crossroads
Gray Rock
Brookston
Columbury
Bearpond
Ashland
Vicksboro
Epsom
Afton
Flat Creek
Fishing Creek
Rocky Cr.
Indian Creek
Crooked
Run
Little Shocco Cr.
Shocco Cr.
Providence Ch.
Richneck
Nutbush Creek
36°35'
36°30'


LOUISBURG
FRANKLINTON
TAR RIVER
GRANVILLE

GENERAL LAND USE
FIGURE II- 27

1, 1960, operations resumed at the mine. When market conditions failed to improve, the mine was again closed in February, 1963. It was opened unsuccessfully at various times until it was closed indefinitely in 1971 (FR-171).

4. Water Programs

The City of Henderson is serviced by a separate sewer collection system and two wastewater treatment facilities. The 1.84 MGD capacity Nutbush Creek plant treats both domestic and industrial wastewaters from the Nutbush Creek and Sandy Creek watersheds. This plant receives about 3,470 pounds of BOD_5 per day and discharges an average 1,350 pounds BOD_5 daily. Total wastewater flows from the Nutbush Creek Basin and the Sandy Creek Basin are approximately 0.81 MGD and 0.73 MGD, respectively. The domestic portion of these flows is approximately 0.51 MGD and 0.48 MGD, respectively. The Nutbush Creek plant currently provides services for approximately 6,000 people in the Nutbush Creek Basin and approximately 5,800 people in the Sandy Creek Basin. Industries in the Nutbush Creek watershed which contribute wastewater to the Nutbush Creek facility include Nu-Southern Dyeing and Finishing and Softspun Knitting Mill. Industries in the Sandy Creek watershed which contribute wastewater to this plant include Americal Corporation and Laurens Glass, Inc. Other industrial wastewaters which are treated at this plant originate from the Taylor Tobacco Company and the Fram Corporation. Wastewater from these two industries is mainly from air conditioning and sanitary facilities. The industrial classifications assigned to the sewage from these industries and the approximate daily wastewater flow to the Nutbush Creek plant is provided in Table II-15.

The 0.24 MGD capacity Red Bud Creek plant treats both domestic and industrial wastes from a tributary domestic population of approximately 3,200. However, the plant currently receives approximately 0.29 MGD of which 0.28 is domestic wastewater. Current organic loading to the plant is 605 pounds BOD_5 per day; an average 133 pounds BOD_5 is discharged daily. The only industrial wastewater treated at this plant originates from the Coca-Cola bottling plant which discharges a flow of approximately 10,000 GPD.

TABLE II-15

INDUSTRIAL CLASSIFICATIONS ASSIGNED TO SEWAGE

NAME OF ESTABLISHMENT	PROCESS FROM WHICH WASTEWATER IS DISCHARGED	4-DIGIT SIC NO.	APPROXIMATE DAILY WASTEWATER FLOW (MGD)
Taylor Tobacco Co.	Tobacco Stemming	2199	0.030
NU-Southern Dyeing & Finishing	Textile Scouring & Dyeing	2299	0.250
Americal Corporation	Textile Hosiery & Dyeing	2299	0.047
Softspun Knitting Mills	Textile Hosiery & Dyeing	2299	0.033
Fram Corporation	Filter Glass	2899	0.041
Laurens Glass	Glass Bottle Production	3221	0.371

Source: NO-096

Results of analysis indicate that the flow during high ground water, including infiltration and inflow, is approximately 1.050 MGD and 0.189 MGD, respectively, for a total of 1.239 MGD in the Nutbush Creek basin; approximately 1.000 MGD and 0.133, respectively, for a total of approximately 1.133 MGD in the Sandy Creek basin; and approximately 0.360 MGD and 0.031 MGD, respectively, for a total of 0.391 MGD in the Red Bud Creek basin. Rehabilitation efforts should reduce the total flow including infiltration/inflow to approximately 1.144 MGD, 0.966 MGD, and 0.347 MGD for the Nutbush Creek basin, Sandy Creek basin, and the Red Bud Creek basin, respectively.

Domestic growth during the planning period will increase the total domestic flow by approximately 0.375 MGD in the Nutbush Creek basin, by approximately 0.420 MGD in the Sandy Creek basin, and approximately 0.200 MGD in the Red Bud Creek basin. Industrial growth is allowed to 10% of the total flow or approximately 0.151 MGD for the Nutbush Creek, 0.134 MGD in the Sandy Creek basin, and 0.053 MGD in the Red Bud Creek basin.

Waste load allocations for the various waste discharges in the 201 planning area were established in the 303(e) basin plan. However, since its completion, waste flows have been revised and the waste load allocations have been modified accordingly by the State of North Carolina. These new revised waste load allocations are presented in Table II-16 and are later used for unit process selection and design for wastewater treatment facilities.

TABLE II-16

WASTE LOAD ALLOCATIONS FOR HENDERSON 201 PLANNING AREA

LOCATION	DESIGN FLOW (MGD)	BOD_5[1] (mg/1)	NH_3-N[2] (mg/1)	TSS[3] (mg/1)	FECAL COLIFORM #/100M1	pH
Red Bud Creek Plant	0.6	5	2	30	200	6-9
Ruin Creek Plant	2.12	5	2	30	200	6-9
	3.70	5	2	30	200	6-9
Sandy Creek Plant	1.52	15	10	30	200	6-9
	2.12	17	6	30	200	6-9
	3.10	17	6	30	200	6-9
	3.70	15	4	30	200	6-9
Nutbush Creek Plant	1.84	17	9	30	200	6-8.5
	3.70	18	7	30	200	6-8.5

[1] 5-Day Biochemical Oxygen Demand
[2] Ammonia Nitrogen
[3] Total Suspended Solids

Source: NO-099

Five small reservoirs located on Sandy Creek within the 201 planning area have served as the source of raw water for the City of Henderson. However, the City's water usage exceeds the safe yield of the supplies from this source, and a new regional water treatment plant has very recently been completed and is now (October, 1976) in operation. The old water supply facilities will not be abandoned, but rather will be maintained as a supplemental water supply.

The new water treatment facilities use Kerr Reservoir as the raw water source; the intake and treatment plant are on the Anderson Swamp Creek finger of the lake, near its confluence with the main Nutbush arm (location W2 of Figure II-12). The plant, with a design capacity of 10.0 MGD, serves the cities of Oxford, Soul City, and Henderson, and the present (initial) average daily use is 4.1 MGD. This existing plant is designed to accommodate the projected growth of these cities over the next 15 years. While alternative courses of action will be evaluated, longer-range plans now include expansion of the regional system to accommodate only the growth of the cities served presently. In 2006, the plant will treat an average 19.1 MGD, and in 2026, an average 27.5 MGD will be treated. Peak flows of 1.5 times the average daily flows are designed to be handled by the system. No changes in the conventional unit processes are anticipated during the expansion for long-term use.

The water rate schedule effective as of July 1, 1975 for the City of Henderson is presented in Table II-17. Sewer charges are 100 percent of the water charge with a maximum of $3,000.00.

TABLE II-1.

CITY OF HENDERSON WATER RATE SCHEDULE

A. MINIMUM MONTHLY WATER RATES:

Quantity in cubic feet	Inside City	Outside City
499 or less through 5/8" meter	$ 2.00	$ 4.00
500 or through 5/8" meter	2.20	4.40
600 or less through 1" meter	2.64	5.28
1,000 or less through 1-1/2" meter	4.40	8.80
2,000 or less through 2" meter	8.80	17.60
4,000 or less through 3" meter	17.60	35.20
10,000 or less through 4" meter	36.60	73.20

B. QUANTITY RATES: (MONTHLY)

Quantity in cubic feet	Inside per 100 cu. ft.	Outside per 100 cu. ft.
First 4,000	.44= 17.60	.88= 35.20
Next 2,000	.35= 7.00	.70= 14.00
Next 6,000	.30= 18.00	.60= 36.00
Next 88,000	.27=237.60	.54=475.20

C. INDUSTRIAL RATES: (MONTHLY)

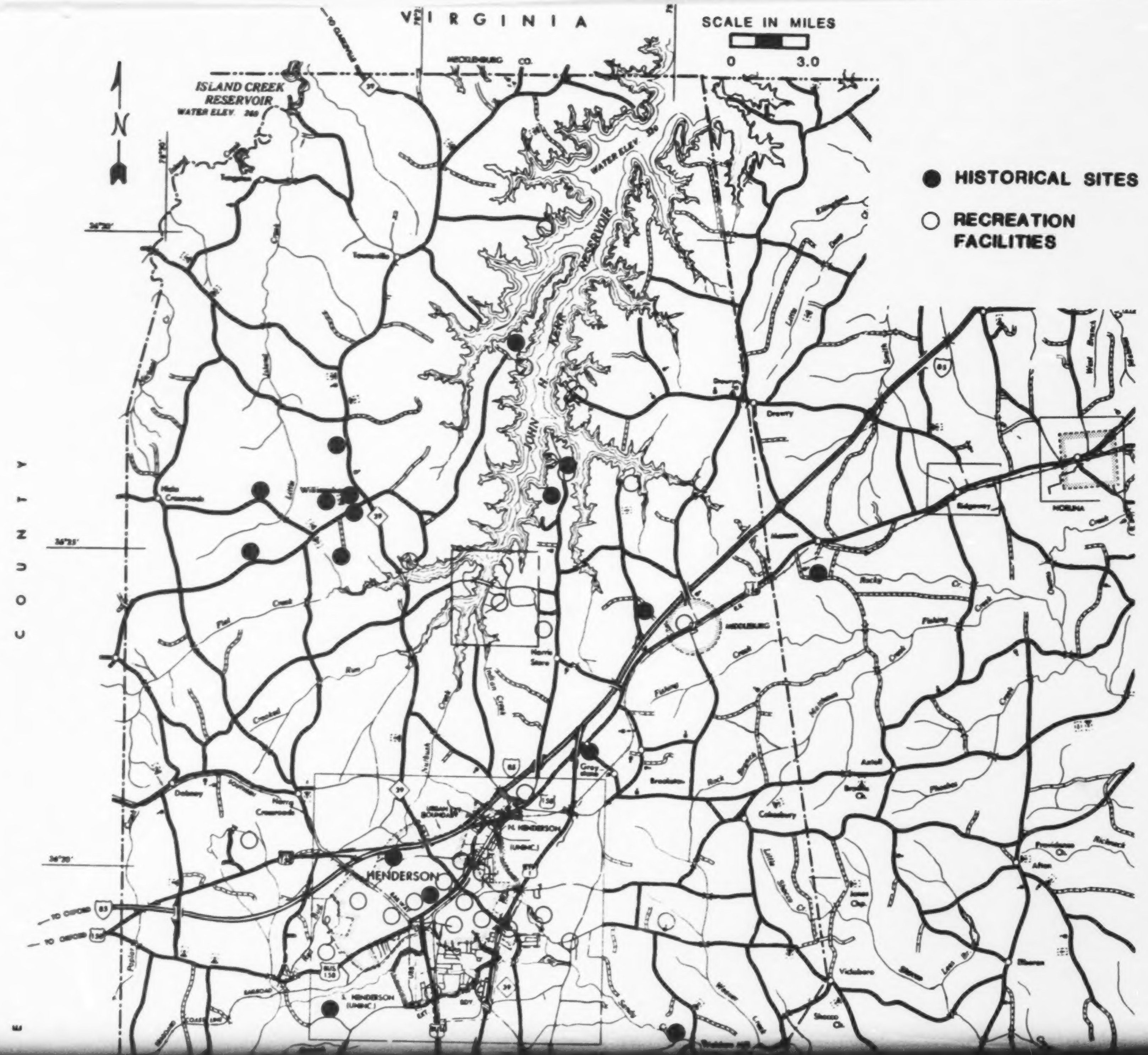
Quantity in cubic feet	Inside	Outside
First 100,000 per 100 feet	.25= 250.00	.50= 500.00
Next 200,000 per 100 feet	.20= 400.00	.40= 800.00
All over 300,000 per 100 feet	.15=	.30=

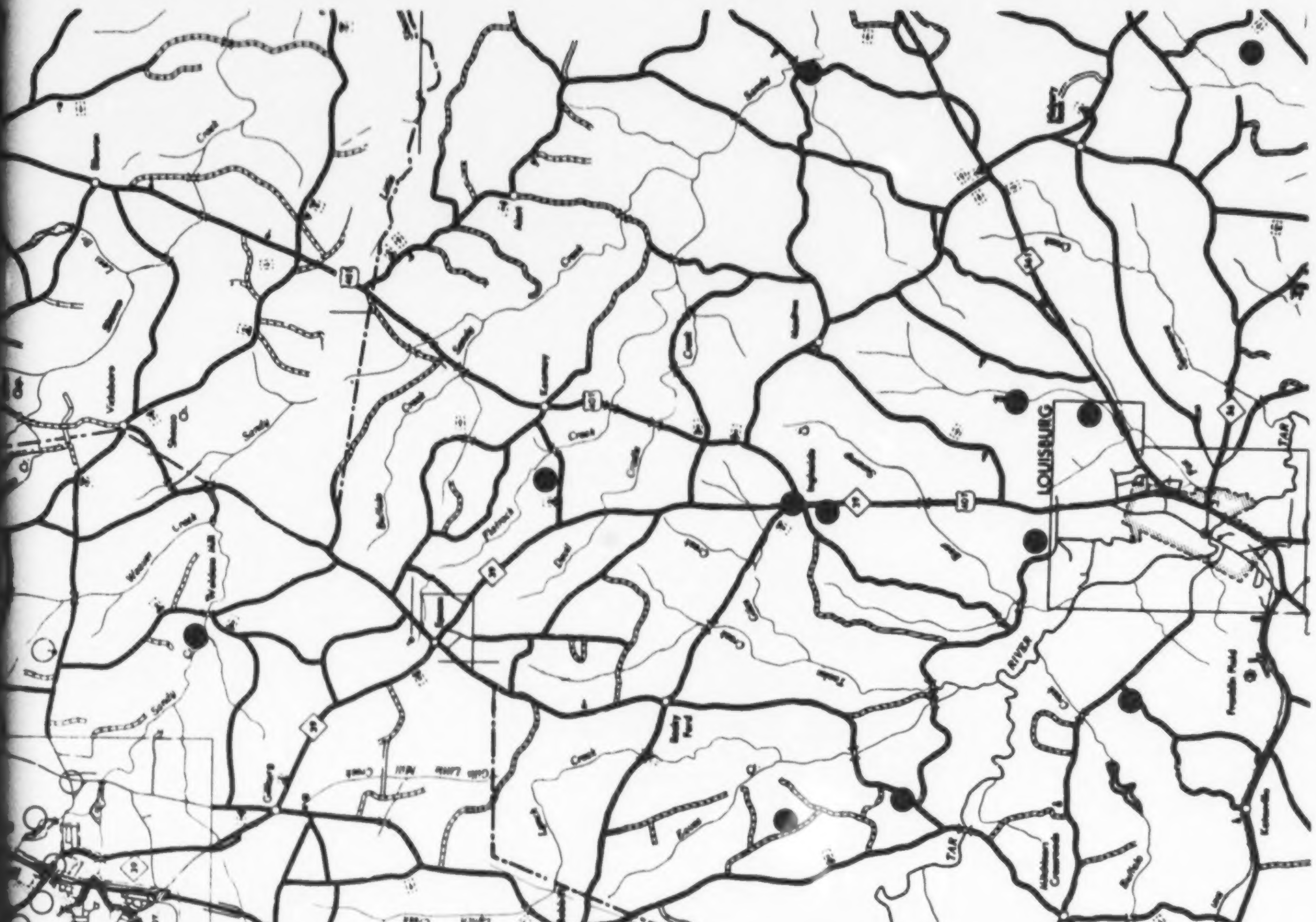
Source: City of Henderson

5. Sensitive Man-Made Areas

Sensitive man-made areas are by definition ones which will have the potential for damage, either irreversible or reversible, caused by direct or indirect actions resulting from project implementation. Generally, those sensitive areas which will be primarily affected will be irreversibly affected and are composed of historical or unique objects or areas. In particular, any historical structures, sites, archaeological sites, and recreational areas located close to or down the watersheds from potential construction and outfall areas are of prime concern. Similarly, structures or sites which fall in or near proposed rights-of-way for new roads or pipelines also require prime consideration. Laurel Mill on Sandy Creek is perhaps the only historical structure which conceivably may be adversely affected by the proposed project. These principal, sensitive man-made areas are shown in Figure II-28.

Secondary categories of sensitive man-made areas are those which may incur retrievable damage, such as built-up areas; commercial, agricultural, or forested lots; recreational areas; and high-use corridors. These areas are shown on preceding figures.


VIRGINIA
SCALE IN MILES
0
3.0
HISTORICAL SITES
RECREATION FACILITIES
MECKLENBURG CO.
ISLAND CREEK RESERVOIR
WATER ELEV. 260
JOHN H. KERR RESERVOIR
WATER ELEV.
Townsville
Williamsboro
Drewry
Ridgeway
NORLINA
MIDDLEBURG
Harris Store
Indian Creek
HENDERSON
N. HENDERSON
S. HENDERSON
Dabney
Harris Crossroads
Kittrell
Cokesbury
Vicksboro
Afton
Manson
Gillburg
Ashford
Rocky Cr.
Fishing Creek
Little Shocco Cr.
Shocco Cr.
Nutbush
Flat Creek
Crooked Run
TO OXFORD
TO CLARKSVILLE
COUNTY
E


LOUISBURG
FRANKLINTON
HENDERSON
TAR RIVER
GRANVILLE

MAN - MADE SENSITIVE AREAS
FIGURE II - 28

III. SYSTEM ALTERNATIVES

A. Identification of Feasible Structural and Non-Structural System Alternatives

The development of feasible system alternatives required for the attainment of the projected goals and objectives was based on a systemmatic method involving the following five major steps:

1. The objectives of the project were defined and examined.
2. Constraints of a regulatory, legal, and administrative nature were determined, as were engineering and fiscal constraints.
3. All reasonable subsystems and subsystem alternatives were delineated. (A subsystem is a process of activity that is an integral part of a treatment scheme.)
4. The identified limitations were applied to the reasonable subsystem alternatives.
5. A descriptive listing of the acceptable subsystem alternatives was prepared.

Potential subsystems available for the attainment of the project objectives included both structural and non-structural alternatives. Structural subsystem alternatives considered were wastewater treatment and associated facilities which must be constructed. Non-structural alternatives were the remaining measures, such as legal and/or administrative decisions which might be adopted to attain the project objectives.

1. Project Objectives

The Federal Water Pollution Control Act Amendments of 1972 (FWPCAA: PL 92-500) were designed to establish a water pollution control program to protect the nation's navigable waters.

The pollution control program which was established by this law includes federal standards for industrial and municipal waste treatment and provisions for federal enforcement, a permit and license system (National Pollutant Discharge Elimination System) which governs the discharge of pollutants into navigable waters, and a massive grant-in-aid program for the construction of publicly-owned waste treatment works. It is the objective of the City of Henderson, North Carolina, to particpate in this federal pollution control program to achieve the current and future water quality goals and objectives and to stimulate or encourage growth, both domestic and industrial, by providing expanded and upgraded wastewater treatment facilities.

The basic objective of the FWPCAA is to eliminate the discharge of pollutants into waters of the United States by 1985. The feasibility or environmental desirability of meeting this "zero discharge" goal by 1985 has not been established. However, the less stringent interim goals and requirements established for 1977 and 1983 will be enforced. Therefore, the Division of Environmental Management of the State of North Carolina, in accordance with Section 303(e) of the FWPCAA has prepared a management plan for the Roanoke and Tar-Pamlico River Basins. This plan identifies those treatment levels required to protect the water quality of these rivers and their tributaries to levels consistent with the 1977 and 1983 interim goals.

Additionally, it is the goal of the City of Henderson, North Carolina, to encourage growth with a continuing supply of jobs and public services. The Regional Land Development Plan for the Kerr-Tar Region was completed by the Regional Planning Staff, Kerr-Tar Regional Council of Governments in June, 1974. This plan was based upon the concept of encouraging growth and provides an analysis of the land development potential of the five counties in the Kerr-Tar Region.

2. Constraints

a. Regulatory, Legal, and Administrative Constraints

In order to receive federal funding for improvements in wastewater treatment facilities and wastewater management techniques, compliance with the treatment requirements specified in the FWPCAA is required. Technology employed must be consistent with Best Practicable Waste Treatment Technology (BPWTT) as defined by the Environmental Protection Agency. To protect the water qualities of the rivers and tributaries in the Roanoke and Tar-Pamlico River Basins and in compliance with the FWPCAA, the Division of Environmental Management of the State of North Carolina prepared a Water Quality Management Plan which sets forth treatment levels required to protect the integrity and quality of the affected receiving bodies of water. Pursuant to this plan, the Division of Environmental Management established waste load allocations for the discharge of treated effluents into existing receiving waters, including Nutbush Creek and Ruin Creek, and potential receiving waters, including Sandy Creek, Tabbs Creek, and the Tar River. Since that time, projected waste flows have been revised, and, consequently, the Division of Environmental Management has recently revised the effluent limitations and produced new waste load allocations. The new allocations are for the existing Red Bud Creek plant (0.6 MGD), the existing Nutbush Creek plant (1.58 MGD and 3.70 MGD), the potential Ruin Creek plant (2.12 MGD and 3.70 MGD), and the potential Sandy Creek plant (1.52 MGD, 2.12 MGD, 3.10 MGD, and 3.70 MGD). These limitations are presented in Table II-16 of Chapter II. Additionally, the Office of Water and Air Resources of North Carolina requires that nitrification be included in the treatment of wastewaters discharged into Nutbush Creek, Sandy Creek, and Ruin Creek to lower the oxygen demand resulting from organic nitrogen and ammonia.

Wastewaters designated for land application must receive pretreatment prior to disposal by any of the available methods, including spray irrigation, overland flow, or infiltration/percolation. However, the State of North Carolina has no specific treatment standards other than a required "good" solids removal to a concentration of approximately 30 mg/ℓ. Additional pretreatment requirements depend on the specific receiving soils' ability to accept and assimilate the waste. Therefore, pretreatment of wastewaters to be disposed of by land application is site-specific and must be considered on a case-by-case basis. The state will grant a permit for such practices upon demonstration of adequate performance.

Currently, Vance County has no zoning ordinances. However, wastewater treatment facilities including interceptors and collectors which are located within the City of Henderson are subject to the city's zoning ordinances, as discussed in Chapter II of this statement. Construction must be in compliance with city ordinances.

b. Engineering and Operational Constraints

Engineering and operational constraints will not only limit the number of feasible subsystem alternatives, but will also encourage the selection of one subsystem over another. The selection of specific unit processes for wastewater treatment or sludge handling is often dependent on the size of the wastewater flow or quantity of sludge produced. For example, the use of trickling filters is ideal for small communities with small waste flows, and the use of sludge drying beds is preferred over the use of vacuum filters or centrifuges when relatively small volumes of sludge are produced.

It is desirable to maximize the use of existing facilities when possible. However, land availability at the two existing sites may restrict or discourage the expansion of the present facilities. Any other new site which may be selected should be sufficient in area to allow for future expansion and/or upgrading.

Pretreatment facilities for land application systems should include the use of aerated lagoons, especially for new wastewater treatment plant locations. Industrial waste loads may constitute a significant quantity of the total waste flow to the pretreatment facility, and more stringent industrial pretreatment may be required by those industries than that required for a more sophisticated pretreatment facility. Therefore, it is recommended that if aerated lagoons are selected for treatment for land application facilities, then at least one other wastewater treatment facility that provides a higher degree of treatment be included in the system, to provide greater flexibility in the system.

c. Fiscal Constraints

The wastewater treatment facilities expansion and improvements for Henderson, North Carolina, are eligible for a 75% federal grant under the provisions of Public Law 92-500 and a 12.5% State Clean Water Bond Grant except for the cost of land and sewer easement. The federal grants program is based on a priority rating for which the City of Henderson has previously qualified and the federal portion is essentially assured. However, the state's grant program is based on a first apply-first receive basis and the program will remain active only while funds are available. Consequently, the state's portion of funding is not assured and may not be available when the application is filed.

A bond referendum in the amount of $1,000,000 was passed by the electorate of the City of Henderson in June, 1973, for the proposed wastewater treatment facilities improvements and expansion. Assuming both federal and state funds will be available, a total projected capital cost (excluding land and easements) of approximately $8,000,000 can be supported without additional local funds. However, if state funds are not forthcoming, a total project cost of only $4,000,000 could be supported and additional local funding will be required.

3. Structural and Non-Structural Subsystem Alternatives

Feasible structural and non-structural subsystem alternatives for the Henderson wastewater treatment facilities were identified and are presented in outline form in Table III-1. Major subsystems include alternatives for collectors and interceptors, treatment plants, effluent disposal, sludge treatment and disposal, and odor and noise control.

4. Development of System Alternatives

a. Existing Facilities

The City of Henderson is located at the headwaters of three drainage basins--Nutbush Creek, Red Bud Creek, and Sandy Creek. Three separate gravity-flow wastewater collection systems are maintained, of which two are naturally tributary to the existing treatment plants located in the Nutbush Creek basin and the Red Bud Creek basin. Wastewater in the Sandy Creek basin is pumped into the Nutbush Creek basin and then flows by gravity to the Nutbush Creek wastewater treatment plant

TABLE III-1

STRUCTURAL AND NON-STRUCTURAL SUBSYSTEM ALTERNATIVES FOR HENDERSON WASTEWATER TREATMENT FACILITIES

I. Collectors and Interceptors
  A. Service area
    1. Existing (no-growth policy)
    2. Expanded as projected
  B. Design capacity
    1. Present demands (no-growth policy)
    2. Projected growth demands
    3. Reduce present and projected demands
      a. Negative growth policy
      b. Water recycle/reuse
      c. Water and sewer rate structure
      d. Rehabilitation of gravity sewers
  C. Phasing of project to meet flow demands
    1. Expand capacity upon demand
    2. Provide facilities for projected demand
  D. Infiltration/inflow
    1. Rehabilitate gravity sewers
    2. Increase treatment capacity

II. Treatment Plant
  A. General
    1. Service area
      a. Existing (no-growth policy)
      b. Expanded as projected
    2. Phasing of project to meet flow demands
      a. Expand capacity upon demand
      b. Provide facilities for projected demand
    3. Phasing of project to meet effluent limitations
      a. Upgrade or construct facilities to meet 1983 limitations
      b. Upgrade or construct facilities to meet 1985 objectives
  B. Location alternatives
    1. Existing
      a. Nutbush Creek
      b. Red Bud Creek
    2. Potential new sites
      a. Sandy Creek below Southerland's pond
      b. Sandy Creek above Southerland's pond
      c. Kerr Lake
      d. Ruin Creek
      e. Tabbs Creek
      f. Other
  C. Treatment processes
    1. Septic tanks
    2. Package facilities
    3. Unit processes
      a. Pretreatment

TABLE III-1
Continued
STRUCTURAL AND NON-STRUCTURAL SUBSYSTEM ALTERNATIVES FOR HENDERSON WASTEWATER TREATMENT FACILITIES

            1) aeration
            2) chlorination
            3) screening
            4) grit removal
            5) flow equalization
        b. Primary treatment
        c. Secondary treatment
            1) Activated sludge
                - conventional
                - contact stabilization
                - extended aeration
            2) Trickling filters
            3) Stabilization ponds/lagoon
            4) Physical-chemical
                - coagulation/flocculation and sedimentation or flotation
                - filtration
                - carbon adsorption
            5) Soil treatment
    D. Advanced waste treatment
        1. Nitrogen removal
            a. Nitrification - denitrification
            b. Ammonia stripping
            c. Break point chlorination
            e. Land application
        2. Phosphorus removal
            a. Alum (Al^{++}) addition
            b. Lime (Ca^{++}) addition
            c. Iron (Fe^{+++}) addition
            d. Land application
        3. Filtration
            a. Slow sand filtration
            b. Rapid sand filtration
        4. Fine solids settling
        5. Carbon Adsorption
    E. Disinfection
        1. Chlorination
        2. Ozonation
        3. Others (heat energy, shortwave radiation, ultrasonic disruption)

III. Treated Effluent Disposal
    A. Surface waters
        1. Kerr Reservoir
        2. Nutbush Creek
        3. Ruin Creek

TABLE III-1

Continued

STRUCTURAL AND NON-STRUCTURAL SUBSYSTEM ALTERNATIVES FOR HENDERSON WASTEWATER TREATMENT FACILITIES

    4. Sandy Creek above Southerland's Pond
    5. Sandy Creek below Southerland's Pond
    6. Tabbs Creek
    7. Tar River
  B. Soil systems
    1. Spray irrigation
    2. Overland flow
    3. Infiltration/percolation
  C. Well disposal
  D. Reuse
    1. Recharge to water supply systems on Kerr Lake
    2. Boiler water make-up
    3. Cooling water for industry
    4. Ground-water recharge

IV. Sludge Treatment and Disposal
  A. Sludge stabilization
    1. Aerobic digestion
    2. Anaerobic digestion
    3. Lime addition
    4. Chlorination
    5. Heat treatment
  B. Sludge thickening
    1. Gravity
    2. Flotation
    3. Centrifuge
  C. Dewatering
    1. Sand beds
    2. Vacuum filters
    3. Centrifuge
    4. Screens
  D. Incineration
  E. Final disposal
    1. Land spread
    2. Landfill
    3. Landfill of incinerator ash

V. Odor and Noise Control at Treatment Plants
  A. Odor Control
    1. Preaeration
    2. Wet scrubber
    3. Unit enclosure
    4. Masking agents
    5. Chemical stabilization
  B. Noise control
    1. Location of treatment facility
    2. Selection of unit processes
    3. Selection of treatment equipment
    4. Performance specification
    5. Design specification

The existing wastewater treatment facilities for Henderson are shown in Figure III-1. Also included are the major interceptors and collectors and the existing Shank Street pumping station and force main.

The Nutbush Creek wastewater treatment plant has a design capacity of 1.84 MGD and includes preliminary treatment, primary clarification, two-stage high-rate trickling filtration, and post chlorination. Sludge is anaerobically digested, air dried on sand drying beds, and ultimately disposed of at the existing sanitary landfill. Effluent is discharged to Nutbush Creek.

The Nutbush Creek wastewater treatment plant receives combined domestic and industrial wastes from the tributary domestic population of 12,000 and six industries at an average daily flow of 1.60 MGD and a peak daily flow of 3.04 MGD. Recent studies indicate that the plant operates at an average treatment efficiency of approximately 61 percent and cannot presently produce the desired effluent quality to protect the water quality of Nutbush Creek. The laboratory facilities at the Nutbush Creek wastewater treatment plant are adequate for present conditions. However, additional laboratory equipment will be required in the future for the sampling and testing program as required by the State and NPDES permits.

Physical characteristics at the Nutbush Creek plant site will impose limitations on any proposed expansion. Available area for such action is limited by two streams which border the existing facilities and any encroachment on these streams may require the construction of berms for flood control. Additionally, the soil in the plant vicinity is of the Wilkes association, which is characterized as shallow to rock, and any required excavation below this shallow soil layer will be relatively expensive.

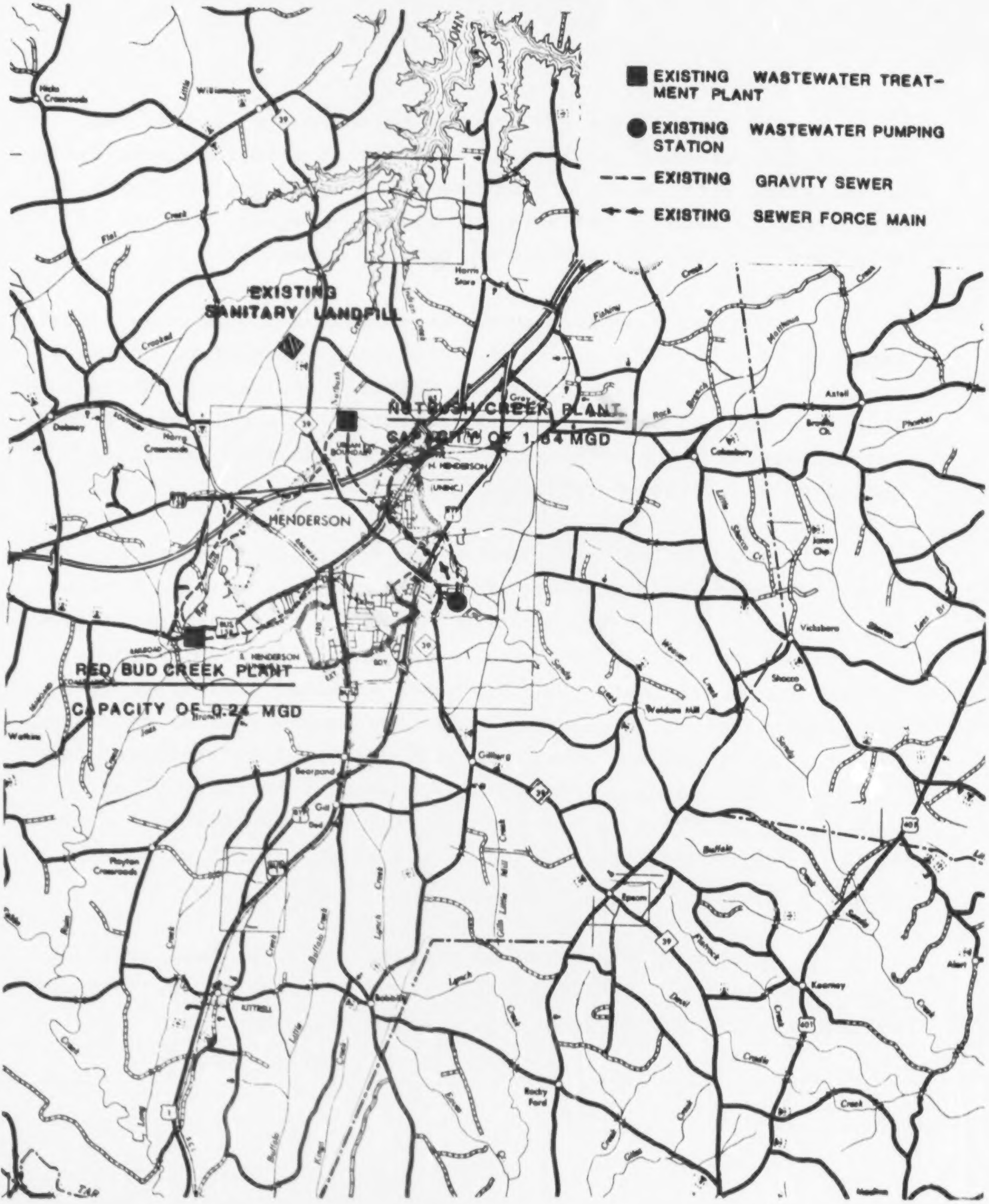

■ EXISTING WASTEWATER TREATMENT PLANT
● EXISTING WASTEWATER PUMPING STATION
- - - EXISTING GRAVITY SEWER
←← EXISTING SEWER FORCE MAIN
EXISTING SANITARY LANDFILL
NUTBUSH CREEK PLANT
CAPACITY OF 1.64 MGD
HENDERSON
N. HENDERSON (UNINC.)
S. HENDERSON
RED BUD CREEK PLANT
CAPACITY OF 0.24 MGD
JOHN
Vicksboro
Gillburg
Bearpond
Epsom
Kearney
KITTRELL
Rocky Ford
Cokesbury
Dabney
Harris Crossroads
Hicks Crossroads
Williamsboro
Poplar Creek Crossroads
Watkins
Weldons Mill
Townsville
Aaron
Rock Branch
Sandy Creek
Buffalo Creek
Flat Creek
Crooked
Fishing
Shocco Cr.
Lynch Creek
Tar
39
1
401

FIGURE III-1
EXISTING FACILITIES

A limited area of land for expansion is located just west of the existing facilities. Additional area requirements may be satisfied with land south of the plant which gently slopes upward from the head of the existing plant. However, the use of this land will require additional pumping capacity.

The Red Bud Creek wastewater treatment plant has a design capacity of 0.24 MGD and includes preliminary treatment, primary clarification, high-rate trickling filters, and post chlorination. Sludge is anaerobically digested, air dried on sand drying beds, and ultimately disposed of at the existing sanitary landfill. Effluent is discharged to Ruin Creek.

The Red Bud Creek wastewater treatment plant receives combined domestic and industrial wastes from the tributary domestic population of 3,000 and one industry at an average daily flow of approximately 0.288 MGD and a peak daily flow of 0.500 MGD. Recent studies indicate that the plant provides an average treatment efficiency of 78 percent. However, during periods of record when the plant was not operating in hydraulically overloaded conditions, the treatment efficiency averaged 86 percent. The treatment facilities do not currently produce an effluent of the quality required for protection of the water quality of Ruin Creek.

Extensive expansion of the Red Bud Creek facilities is limited by land availability. The plant is bordered on two sides by highways and by Red Bud Creek on the remaining side.

b. Description of Alternatives

A total of 15 system alternatives including the "no-action" alternative received environmental and cost evaluations. A summary description of these alternatives is provided in Table III-2.

To maintain the existing facilities as they are now operating would constitute a type of "no-action" approach to wastewater treatment. However, the regulatory constraints discussed in Section III.A.2.a. clearly eliminates a true "no-action" alternative. Consideration of a "no-action" alternative is mandated by the National Environmental Policy Act guidelines. Therefore, the "no-action" alternative was defined to include upgrading but no expansion of existing facilities to meet 1983 discharge requirements (see Alternative 13 in Table III-2). This "no-action" alternative also would involve expenditure of federal funds.

Detailed descriptions with location maps of the various components required for each of the system alternatives are presented in the Technical Reference Document (RA-R-276). This information was used for both the environmental and economic assessment of these alternatives.

B. Evaluation of Feasible Structural and Non-Structural Alternatives

The evaluation of the environmental impacts and the economic costs of the system alternatives is summarized in this section. A more detailed account of the evaluations is included in the Technical Reference Document (RA-R-276). In this section the methodology utilized in the evaluation is reviewed first, and is followed by presentation of the results. A final subsection gives the conclusions based on the analysis of the alternatives.

TABLE III-2

SYSTEM ALTERNATIVES EVALUATED IN THE ENVIRONMENTAL IMPACT STATEMENT

	NUTBUSH CREEK PLANT (EXISTING FACILITY)	RED BUD CREEK PLANT (EXISTING FACILITY)	SANDY CREEK PLANT (NEW FACILITY)	LAKE KERR PLANT (NEW FACILITY)	RUIN CREEK PLANT (NEW FACILITY)	REMARKS
EXISTING FACILITIES	1.84 MGD	0.24 MGD				
ALTERNATIVES						
1	1.58 MGD	0.60 MGD	1.52 MGD			
2	1.58 MGD	ABANDON	2.12 MGD			PUMP RED BUD CREEK TRIBUTARY WASTEWATER TO SANDY CREEK BASIN.
3	ABANDON	0.60 MGD	3.10 MGD			PUMP NUTBUSH CREEK TRIBUTARY WASTEWATER TO THE SANDY CREEK BASIN.
4	ABANDON	ABANDON	3.70 MGD			PUMP BOTH NUTBUSH CREEK AND RED BUD CREEK CREEK TRIBUTARY WASTEWATER TO SANDY CREEK BASIN.
5	ABANDON	ABANDON		3.70 MGD		PUMP BOTH SANDY CREEK AND RED BUD CREEK TRIBUTARY WASTEWATER TO NUTBUSH CREEK BASIN. PROVIDE OUTFALL AND DIFFUSER TO KERR LAKE FROM NEW KERR LAKE PLANT.
6	ABANDON	0.6 MGD	3.10 MGD			PUMP NUTBUSH CREEK TRIBUTARY WASTEWATER TO SANDY CREEK BASIN. PROVIDE PRETREATMENT OF BOTH RED BUD CREEK PLANT AND THE SANDY CREEK PLANT AND LAND DISPOSE OF WASTEWATER ON SUITABLE SITE.
7	1.58 MGD	ABANDON	2.12 MGD			PUMP THE RED BUD CREEK TRIBUTARY WASTEWATER TO THE SANDY CREEK BASIN. PROVIDE PRETREATMENT AT BOTH THE NUTBUSH CREEK PLANT AND THE SANDY CREEK PLANT AND LAND DISPOSE OF THE WASTEWATER ON SUITABLE SITES.
8	1.58 MGD	ABANDON	2.12 MGD			PUMP THE RED BUD CREEK TRIBUTARY WASTEWATER TO THE SANDY CREEK BASIN. LOCATE NEW SANDY CREEK PRETREATMENT FACILITY IN VANCE COUNTY AND PROVIDE PRETREATMENT WITH AERATED LAGOONS. LAND DISPOSE OF THE PRETREATED WASTEWATER FROM THE SANDY CREEK PLANT AT A SUITABLE SITE.
9	1.58 MGD	ABANDON			2.12 MGD	PUMP SANDY CREEK TRIBUTARY WASTEWATER TO THE RED BUD CREEK BASIN.
10	ABANDON	ABANDON			3.70 MGD	PUMP BOTH NUTBUSH CREEK AND SANDY CREEK TRIBUTARY WASTEWATER TO RED BUD CREEK BASIN.
11A	3.10 MGD	0.60 MGD				PUMP SANDY CREEK TRIBUTARY WASTEWATER TO NUTBUSH CREEK BASIN. PROVIDE OUTFALL AND DIFFUSER TO KERR LAKE FROM NUTBUSH CREEK PLANT.
11B	3.10 MGD	0.60 MGD				PUMP SANDY CREEK TRIBUTARY WASTEWATER TO NUTBUSH CREEK CREEK BASIN. DISCHARGE TO NUTBUSH CREEK.
12A	3.70 MGD	ABANDON				PUMP BOTH THE SANDY CREEK TRIBUTARY WASTEWATER AND THE RED BUD CREEK TRIBUTARY WASTEWATER TO THE NUTBUSH CREEK BASIN. PROVIDE OUTFALL AND DIFFUSER TO KERR LAKE FROM NUTBUSH CREEK PLANT.
12B	3.70 MGD	ABANDON				PUMP BOTH THE SANDY CREEK TRIBUTARY WASTEWATER AND THE RED BUD CREEK TRIBUTARY WASTEWATER TO THE NUTBUSH CREEK BASIN. DISCHARGE TO NUTBUSH CREEK.
13	NO ACTION					

1. General Methodology

The methodology for evaluating alternatives was the development of independent rankings of costs, using various economic measures of effectiveness, and of environmental impact, gaged from the superposition of the various treatment systems, described in the first part of this chapter, on the environment of the study area, as described in Chapter II.

a. Environmental Rankings

The fifteen alternatives were evaluated for environmental impact using a systematic, comprehensive approach. The number of alternatives could have been reduced before this evaluation by using more restrictive engineering constraints; however, the larger number was evaluated to produce a broad-based assessment in order to facilitate generalizations and comparisons.

The basic approach for each alternative evaluation was to generate a Figure of Merit (FOM) based on (1) the relative importance of various specific environmental categories as perceived by a local citizen review group, and (2) an objective enumeration of adverse impacts of components by an unbiased, multidisciplinary professional group using environmental criteria with a one-to-one correspondence to the citizens' environmental categories. The environmental criteria and categories employed in the evaluation system and their correspondence are shown in Table III-3. (A land use plan for the area does not exist; all alternatives were assumed to have equal impact on the unknown future land use.) The evaluation process is one of the minimizing adverse impacts, unmitigated by other measures, rather than optimizing the mix of beneficial and adverse impacts. The FOM

TABLE III-3

CORRESPONDENCE BETWEEN EVALUATION CRITERIA AND IMPORTANCE CATEGORIES

Natural Environment

	Evaluation Criteria*	Citizens' Importance Categories
1.	Air quality impact	General air quality
2.	Frequency and extent of odor problems	Odor
3.	Short-term noise during construction	Short-term noise
4.	Rural and/or urban long-term noise	Long-term noise
5.	Suitability of substrate for intended use	Limiting land use to naturally suitable uses
6.	Dissolved oxygen and salinity of area streams	General water quality of area streams
7.	Physicochemical effects of nutrient and BOD loadings on limnology	General water quality of Kerr Reservoir
8.	Potential for siltation and turbidity increases	Aesthetics of streams
9.	Potential for algal growth, excess aquatic plants and sludges	Aesthetics of ponds and Kerr Reservoir
10.	Alteration of natural streamflow	Maintenance of existing streamflow
11.	Potential for altering subsurface drainage	Maintenance of existing ground-water levels
12.	Potential for adversely affecting nearby consumers of surface and ground water	Protection of public and private water supplies
13.	Potential for degrading ground-water quality	General quality of ground water
14.	Impacts on natural vegetation	Natural vegetation
15.	Potential disturbance of rare, unique, or endangered species of terrestrial flora	Existence of rare plants
16.	Potential disturbance of rare, unique or endangered species of terrestrial fauna	Existence of rare land animals of all types
17.	Significant changes in bird populations and habitat	Number of types and abundance of birds
18.	Significant changes in populations and and habitat for other terrestrial animals	Number of types and abundance of land animals
19.	Potential disturbance of rare, unique, or endangered species of aquatic fauna	Existence of rare aquatic animals
20.	Significant changes in fish populations and habitat	Number of types and abundance of fish

* Numbers augmented qualitatively by "Red/Green Flags" in final listing.

TABLE III-3 (Cont.)

CORRESPONDENCE BETWEEN EVALUATION CRITERIA AND IMPORTANCE CATEGORIES

	Evaluation Criteria		Citizens' Importance Categories
21.	Significant changes in populations and habitat for aquatic fauna		Number of types and abundance of other water-based animals
22.	Disruption of relatively undisturbed ecosystem		Unusual natural areas
			Manmade Environment
	Existing Areas Physically Affected by Construction or Operation		Existing Land Use
1.a.	Urban residential area	a.	Urban residential
2.b.	Rural residential area	b.	Rural residential
3.c.	Commercial, retail areas	c.	Commercial, retail
4.d.	Agricultural land	d.	Farming
5.e.	Silvicultural tracts	e.	Forestry
6.f.	Industrial	f.	Industrial
7.g.	Institutional	g.	Institutional
8.h.	Water-oriented recreation areas	h.	Areas for swimming, skiing, fishing, boating
9.i.	Other designated recreational areas	i.	Other outdoor recreational activities
10.j.	Historical structures and sites	j.	Local historical points of interest
11.k.	Local archaeological areas of interest	k.	Local archaeological sites
12.1.	Unusually scenic areas	l.	Aesthetic natural areas
13.	Number of, and traffic at, roadcrossings		Short-term disruption of surface transportation system
*14-24			
**25.	Complexity of operating treatment system		Wastewater treatment by sewage treatment plants
**26.	Relative capital and operating costs		Taxes and capital budgeting
**27.	Energy consuption in operation		Energy conservation, exclusive of cost
**28.	Adequacy of existing community services		Community services other than sewage treatment
**29.	Differential economic growth potential		Employment opportunities and economic growth
**30.	Hazards to public health		Public health
**31.	Growth restriction imposed by project		Maintenance of existing quality of life without population increase
**32.	Potential for population growth		Maintenance of existing quality of life with population increase
**33.	Effects of Federal projects and programs		Ongoing Federal projects and programs in area
**34.	Effects on other projects and programs		Ongoing state, regional and local projects in area

* Criteria and categories 14-24 represent specific future land uses which are the same as 1-10; these are unknown and not evaluated in the alternative analysis.

**Must be evaluated at Systems Alternative level.

rating is supplemented by a listing of "Red Flags," or major adverse impacts, and "Green Flags," substantial beneficial impacts other than the lack of "adverse" impacts. The details of the environmental evaluation system are presented in the Technical Reference Document (RA-R-276).

b. Cost Rankings

The costs for each of the unit processes for the wastewater treatment facilities were estimated using information sources that are in general use for this purpose (ST-352; VA-123; PO-167) and information contained in the Henderson 201 Facilities Plan (WO-097). Wastewater treatment plant design for cost estimates is based on waste load allocations as imposed by the State of North Carolina.

In accordance with good engineering design practices, maximum use of existing unit processes was assumed for systems utilizing existing wastewater treatment facilities. Two-stage aeration facilities with extended aeration capability for biological nitrification followed by fine solids settling, post aeration and chlorination were the basis for estimating the cost of new wastewater treatment facilities. The use of both extended aeration and aerated lagoons was considered for pretreatment of wastewater prior to land application. All biological sludges were considered to be either anaerobically or aerobically digested at existing sites and aerobically digested at new facilities. The design includes stabilization of biological sludges by air drying on sand drying beds and ultimate disposal at the existing sanitary landfill. Phosphorus and nitrogen removal are not included in the design basis for any alternative system since nutrient removal is not specified by the design effluent limitations.

2. Results

The rankings produced by the environmental and economic evaluations of the alternatives are presented in the following subsections.

a. Environmental Rankings

The assembled citizens' review group reviewed the environmental categories and judged their relative importance to the environment. The values were normalized, averaged, and squared (see RA-R-276) to reduce the citizens' responses to a single weighting function for each category. The categories have been arranged in the order of perceived importance in Table III-4. Protection of public and private water supplies is by far of most importance to the citizens of the area, with a weighting value of 2.23; other categories have weighting values normally distributed through the range from 1.75 to 0.25, as shown in Table III-4.

An objective enumeration of the adverse impacts engendered by each of the 36 system components was performed by the multidisciplinary professional jury. Graphic displays of rated impacts for all 56 environmental categories and for the various system components, may be found in the Technical Reference Document (RA-R-276). Table III-5 presents the number of times each environmental criterion received a red flag for the various alternatives.

TABLE III-4
ORDER OF IMPORTANCE OF ENVIRONMENTAL CATEGORIES

WEIGHTING FACTOR	RANKINGS			CATEGORY
	CUMULATIVE	NATURAL ENVIRONMENT	MAN-MADE ENVIRONMENT	
2.23	1	1		Protection of public and private water supplies
1.75	2		1	Wastewater treatment by sewerage plants
1.70	3	2		General water quality in area streams
1.60	4		2	Existing land uses - local points of historical interest
1.59	5		3	Public health
1.57	6	3		General quality of ground water
1.53	7		4	Taxes and capital budgeting
1.51	8		5	Ongoing state, regional and local projects in the area
1.48	9		6	Future land uses - land-based recreation
1.42	10		7	Community services other than sewage treatment
1.39	11	4		Odor
1.38	12		8	Existing land uses - areas used for swimming, fishing, boating, skiing
1.36	13	5		General water quality of Kerr Reservoir
1.24	14	6		Maintenance of existing ground water levels
1.23	15	7		Aesthetics of ponds and Kerr Reservoir
1.22	16		9	Future land use - farming
1.18	17	8		Maintenance of existing streamflow
	18		10	Existing land uses - other outdoor recreational facilities
1.17	19		11	Energy consumption exclusive of cost
1.16	20		12	Aesthetic natural areas
1.15	21		13	Existing land uses - rural, residential
1.14	22	9		Number of types and abundance of fish
	23		14	Employment opportunities and economic growth
1.12	24	10		Limiting land use to naturally suited areas
1.10	25	11		Aesthetics of streams
1.09	26		15	Future land uses - industrial
1.06	27		16	Future land uses - rural, residential
	28		17	Maintenance of existing quality of life without population increase

TABLE III-4 (Cont.)

ORDER OF IMPORTANCE OF ENVIRONMENTAL CATEGORIES

WEIGHTING FACTOR	RANKINGS			CATEGORY
	CUMULATIVE	NATURAL ENVIRONMENT	MAN-MADE ENVIRONMENT	
1.01	29		18	Existing land uses - farming
0.98	30	12		Long-term noise
0.95	31		19	Future land uses - water-oriented recreation
0.91	32	13		Natural vegetation
	33		20	Existing land uses - urban residential
0.89	34		21	Existing land uses - forestry
0.88	35	14		General air quality
0.86	36		22	Existing land uses - industrial
0.85	37	15		Number of types and abundance of land animals
0.84	38	16		Existence of rare land animals of all types
	39		23	Future land uses - forestry
0.81	40	17		Unusual natural areas
0.79	41		24	Future land uses - transportation
0.77	42		25	Future land uses - commercial, retail
	43		26	Maintenance of quality of life with population increases
	44	18		Number and types of other water-based animals
	45		27	Existing land uses - commercial, retail
0.76	46		28	Existing land uses - institutional
0.72	47		29	Future land uses - rural, residential
0.65	48		30	Ongoing federal projects and programs in the area
0.62	49		31	Future land uses - historical and archaeological
0.59	50	19		Number of types and abundance of birds
0.58	51		32	Future land uses - institutional
0.44	52	20		Short-term noise
	53	21		Existence of rare aquatic animals
0.40	54		33	Existing land uses - local archaeological sites
0.36	55		34	Short-term disturbance of surface transportation system
0.25	56	22		Existence of rare plants

TABLE III-5

SUMMARY OF RED AND GREEN FLAGS

		1	2	3	4	5	6	7	8	9	10	11A	12A	13	11B	12B
	SYSTEM	NB-1.84 SC-1.52 RB-0.6	NB-1.84 SC-2.12	SC-3.1 RB-0.6	SC-3.7	RB-3.7	RB-0.6-LD SC-3.1-LD	NB-1.84-LD SC-2.12-LD	NB-1.84 SC-2.12-LD	NB-1.84 RC-2.12	RC-3.7	NB-3.1 RB-0.6	NB-3.7	No-Action	NB-3.1 RB-0.6	NB-3.7
	RED FLAGS-TOTAL	9	8	12	12	7	10	8	6	25	24	9	9	11	12	12
	***GREEN FLAGS	-	-	-	-	AB	C	C	C	BD	B	B	B	-	B	B
	EVALUATION CRITERIA						**RED FLAGS									
NATURAL ENVIRONMENT	1. Air quality															
	2. Odor problems														X	X
	3. Short-term noise			X	X	X	X					X	X		X	X
	4. Long-term noise															
	5. Substrate Suitability													X		
	6. H_2O Quality-Streams*									X	X			X		
	7. H_2O Quality-Kerr													X	X	X
	8. Siltation and turbidity	XX	XX	XX	XX	XX	XX	XX	XX	XXXX	XXX	XXX	XXX		XX	XX
	9. Algal growth/aquatic plants/sludges									X	X				X	X
	10. Natural streamflow	X	X	X	X						X				X	X
	11. Subsurface drainage															
	12. Water consumers*													X		
	13. Ground-water quality*						X	XX	X							
	14. Natural vegetation	X	X	X	X	X	X	X	X	XXX	XXX	X	X		X	X
	15. Rare terrestrial plants									X	X					
	16. Rare terrestrial animals															
	17. Bird populations									X	X					
	18. Terrestrial animals									X	X					
	19. Rare aquatic fauna									XX	XX					
	20. Fish populations									X	X					
	21. Aquatic fauna population									XX	XX					
	22. Undisturbed ecosystems	X	X	X	X	X	X	X	X	XXXX	XXXX	X	X		X	X
MAN-MADE ENVIRONMENT EXISTING	1. Urban residential															
	2. Rural residential															
	3. Commercial, retail															
	4. Agricultural	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	5. Silvicultural															
	6. Industrial													X		
	7. Institutional															
	8. Water-oriented recreation*	X	X	X	X										X	X
	9. Other recreation															
	10. Historical sites*			X	X											
	11. Archaeological areas									X	X					
	12. Scenic areas									X	X					
	13. Traffic			XX	XX		XX					X	X		X	X
FUTURE	14. Urban residential															
	15. Rural residential															
	16. Commercial, retail															
	17. Agricultural															
	18. Silviculture															
	19. Industrial															
	20. Institutional															
	21. Non-water recreation															
	22. Water-oriented recreation															
	23. Transportation networks															
	24. Historical/archaeological															
	25. STP complexity													X		
	26. Capital & operating *					X	X	X		X		X		X		
	27. Energy consumption	X											X	X		
	28. Existing community services															
	29. Economic growth potential													X		
	30. Public health hazards															
	31. Growth restrictions															
	32. Population growth															
	33. Fed. projects & programs	X	X	X	X									X		
	34. Other projects & programs															

* Correspond to environmental categories of large importance to citizens of the area (weighting factor ≥1.33).

** Number of X's is times criteria is flagged within a system.

***Refers to differential beneficial impacts beyond lack of adverse impact. All alternatives will produce benefits in the form of increased public health protection, improved stream quality, etc., relative to existing conditions.

A - Potential to service developing areas near lake and reduce WQ degradation from septic tanks.

Ability to utilize all of present water supply system as a supplementary supply.

Increased crop production and/or revenues from "naturally" fertilized land offsets cost of operating system.

'gh flexibility to accommodate all types of growth on an areal basis.

Manipulation of the weighting function values determined by the citizens' review groups and the values assigned to the environmental criteria by the multidisciplinary jury resulted in the establishment of a final environmental ranking of the proposed alternatives. This final environmental ranking is displayed in Table III-6.

TABLE III-6

ENVIRONMENTAL RANKING OF SYSTEM ALTERNATIVES

RANK	VALUE*	SYSTEM ALTERNATIVE
1	5.26	4
2	4.68	8
3	4.64	3
4	4.56	2
5	4.41	10
6	4.40	12A
7	4.34	7
8	4.33	12B
9	4.30	5
10	3.95	6
11	3.56	1
12	3.50	11B
13	3.41	11A
14	3.00	9
15	0.40	13

---

*Higher numbers are more environmentally acceptable.

b. Cost Rankings

Detailed cost estimates for each system alternative including capital costs and operation and maintenance costs are provided in the Technical Reference Document (RA-R-276). The cost estimates reported are not necessarily the final cost estimates for construction of the facilities. The final estimates will be determined by the construction contractor and will reflect current equipment and construction costs at the time of construction. The cost estimates contained herein do approximate the expected costs and provide a sound basis for a confident cost evaluation and comparison.

The cost summary and comparison of system alternatives are provided in Table III-7. Total capital costs are amortized over a 20-year period at an interest rate of 6.125 percent and are added to the respective total annual operation and maintenance costs to determine total annual cost. Total annual operation and maintenance costs are based on a design flow of 3.70 MGD. Additionally, the total treatment cost of each system alternative is provided to facilitate economic ranking.

TABLE III-7

COSTS SUMMARY AND COMPARISON OF SYSTEM ALTERNATIVES

SYSTEM ALTERNATIVES	CAPITAL COSTS ($)	AMORTIZED CAPITAL COST[1] ($/YR)	O&M COST[2] ($/YR)	TOTAL ANNUAL COST ($/YR)	TOTAL TREATMENT[2] COST ($/MG)
13[3]	4,441,000	393,400	304,500	697,900	516
12B	6,102,000	537,100	273,000	810,000	600
11B	6,502,000	572,400	353,400	925,800	686
12A	7,892,000	694,700	275,200	969,900	718
2	6,957,000	612,400	398,700	1,011,100	749
1	6,654,000	585,700	464,100	1,049,800	777
5	8,747,000	770,000	298,600	1,059,600	785
8	8,257,000	726,800	335,000	1,061,800	786
11A	8,293,000	730,000	355,400	1,085,400	804
9	8,116,000	714,400	391,700	1,106,100	819
4	9,024,000	794,400	332,500	1,126,900	834
10	9,644,000	848,900	314,400	1,163,300	861
3	8,862,000	780,100	410,100	1,190,200	881
7	13,131,000	1,155,900	383,400	1,539,300	1,140
6	14,652,000	1,289,800	439,600	1,729,400	1,281

[1] Based on 20 years @ 6-1/8% interest for WWTP's and 30 years @ 8% for septic tanks.
[2] Based on design flow of 3.70 MGD.
[3] Assuming accommodation of design population severed by WWTP's and septic tanks.

Table III-8 provides a present worth cost ranking and the associated user's costs for the fifteen alternatives including the "no-action" alternative. Assumptions for the present worth analysis include an interest rate of 6.125 percent, a useful life of 30 years for all structures, 40 years for all piping, and a design period of 20 years. Land is assumed not to depreciate.

User's cost is based on the total local capital costs and municipal operation and maintenance costs for a sewered population of 23,115.

TABLE III-8

PRESENT WORTH AND USER'S COSTS OF SYSTEM ALTERNATIVES

RANKING	SYSTEM ALTERNATIVE	PRESENT WORTH MILLION $	ANNUAL USER'S COST (FEDERAL GRANT) ($/PERSON)	ANNUAL USER'S COST (FEDERAL & STATE GRANT) ($/PERSON)
1	13	6.738	10.60	9.80
2	12B	9.096	14.10	11.20
3	11B	10.373	16.90	13.80
4	12A	10.676	15.80	12.10
5	2	11.285	18.70	15.40
6	8	11.695	19.70	16.10
7	5	11.759	17.10	13.00
8	1	11.774	20.40	17.20
9	11A	11.950	18.70	14.70
10	9	12.187	19.60	15.70
11	4	12.554	18.70	14.40
12	10	12.852	18.70	14.10
13	3	13.300	20.90	16.70
14	7	16.567	27.20	21.40
15	6	18.577	30.40	23.90

3. Conclusions

On the basis of the environmental and economic cost rankings presented in the preceding section, the U.S. Environmental Protection Agency and the State of North Carolina eliminated from further consideration all but three alternative systems: numbers 2, 4, and 12B. Each of these had relative important advantages and disadvantages and no one system seemed clearly superior to the others. To obtain more detailed information on these systems and to hasten the decision-making process, all three systems were selected as "proposed actions" in the terminology of the National Environmental Policy Act. The impacts of all three systems are assessed in equal detail as the focus of this Draft Environmental Impact Statement. After the public review and comment period on this draft statement and after appropriate modifications to the statement are incorporated in the decision-making, one of the systems (2, 4, or 12B) will be jointly selected by EPA and the State of North Carolina as the proposed action for the Final EIS. For the draft impact assessment (Chapters IV, V, and VI), system alternatives 2, 4, and 12B are designated Alternatives A, B, and C, respectively.

IV. DESCRIPTION OF THE PROPOSED ACTIONS

To place the proposed actions into perspective, a brief description of existing wastewater treatment systems will be followed by descriptions of each alternative that was subjected to detailed environmental analysis.

A. Existing System

The City of Henderson is currently serviced by two wastewater treatment plants including a 1.84 MGD plant located on Nutbush Creek and a 0.24 MGD plant located on Red Bud Creek.

The Nutbush Creek plant provides facilities for preliminary treatment, primary treatment, secondary treatment, and post chlorination. The preliminary treatment facilities include a manually-cleaned bar rack, a mechanically-cleaned circular grit collector, a communitor, a manually-cleaned bar screen, and a Parshall flume for flow measuring. Primary treatment is accomplished with three parallel rectangular settling tanks. Secondary treatment is achieved by two circular trickling filters operating in series followed by secondary clarification. The treated wastewater receives post chlorination prior to discharge to Nutbush Creek. Sludge is withdrawn from the primary clarifier settling tanks and stabilized by two-stage anaerobic digestion. The stabilized sludge is air-dried on sand drying beds and later removed for ultimate disposal at the existing landfill site.

The Red Bud Creek plant provides facilities for preliminary treatment, primary treatment, secondary treatment, and post chlorination. The preliminary treatment facilities include a longitudinal manually-cleaned grit chamber, a barminutor, and a manually-cleaned bar screen. Primary treatment is accomplished with a circular primary clarifier which is combined with an anaerobic digester (clarigester). Secondary treatment is attained with a single circular trickling filter followed by secondary clarification. The treated wastewater receives post chlorination prior to discharge to Ruin Creek. Sludge is anaerobically digested in the clarigester, air-dried on sand-drying beds, and ultimately disposed of at the existing landfill site.

B. Selected Alternatives

Three system alternatives were selected to receive further evaluation in this Draft Environmental Impact Statement. They are Alternatives 2, 4, and 12B and will, for the sake of clarity, be referred to as Alternatives A, B, and C, respectively, in the remainder of the document.

1. Alternative A

Alternative A recommends retaining the existing Nutbush Creek plant, at a new design capacity of 1.58 MGD, abandoning the existing Red Bud Creek plant, and constructing a new 2.12 MGD facility on Sandy Creek below Southerland's Pond. An illustration of this alternative, including the general location of major interceptors and collectors, is presented in Figure IV-1.

The existing facilities can be supplemented with additional unit processes to satisfy effluent limitations. An aeration system followed by secondary clarification will be required to achieve nitrification. Before final discharge into the Nutbush Creek arm of Kerr Reservoir, the effluent should receive post aeration. An additional aerobic digester will be necessary to stabilize any sludge produced from nitrification. A general layout of the proposed improved facility is presented in Figure IV-2.

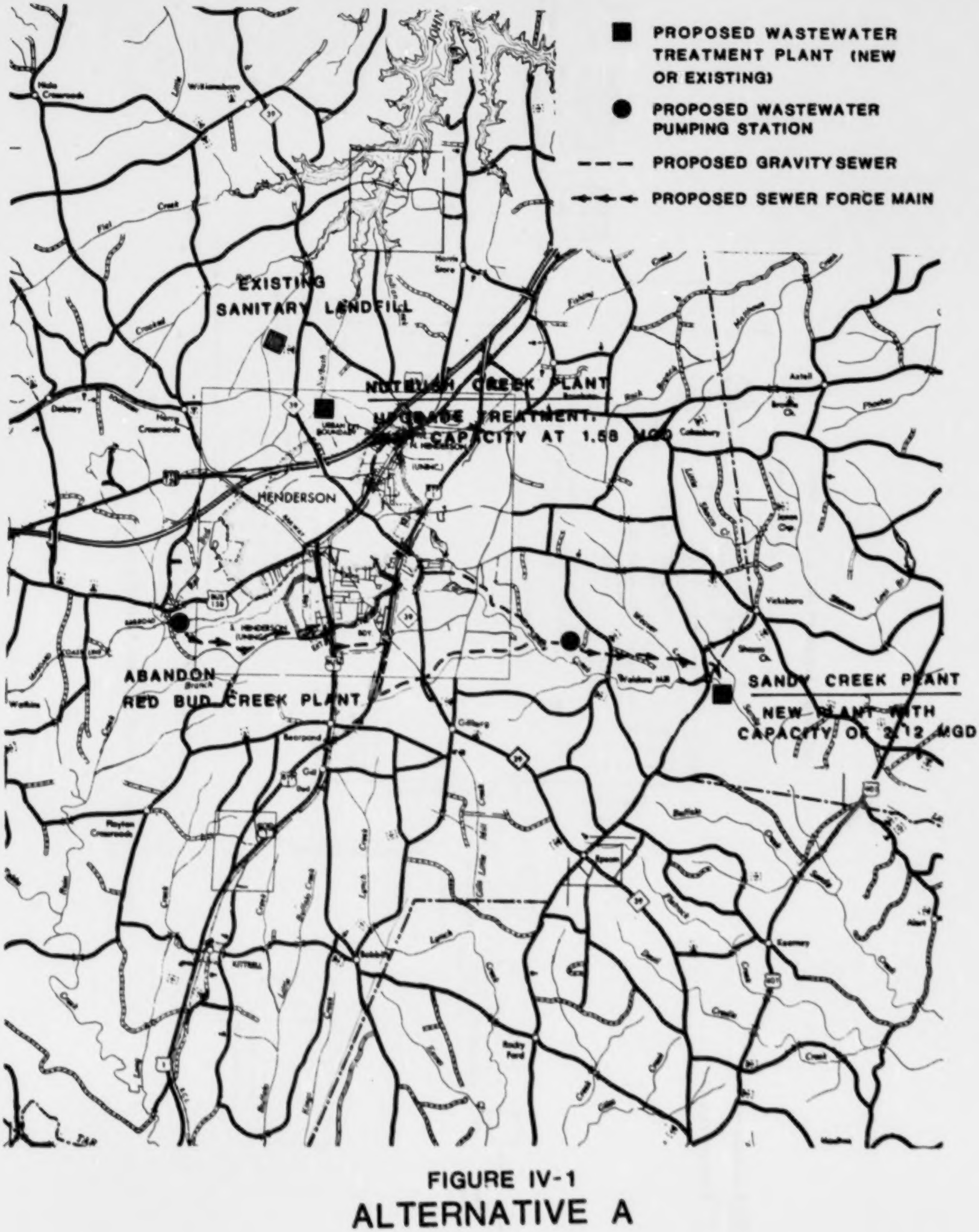

PROPOSED WASTEWATER TREATMENT PLANT (NEW OR EXISTING)
PROPOSED WASTEWATER PUMPING STATION
PROPOSED GRAVITY SEWER
PROPOSED SEWER FORCE MAIN
EXISTING SANITARY LANDFILL
NUTBUSH CREEK PLANT
UPGRADE TREATMENT, CAPACITY AT 1.58 MGD
HENDERSON
ABANDON RED BUD CREEK PLANT
SANDY CREEK PLANT
NEW PLANT WITH CAPACITY OF 2.12 MGD

FIGURE IV-1
ALTERNATIVE A

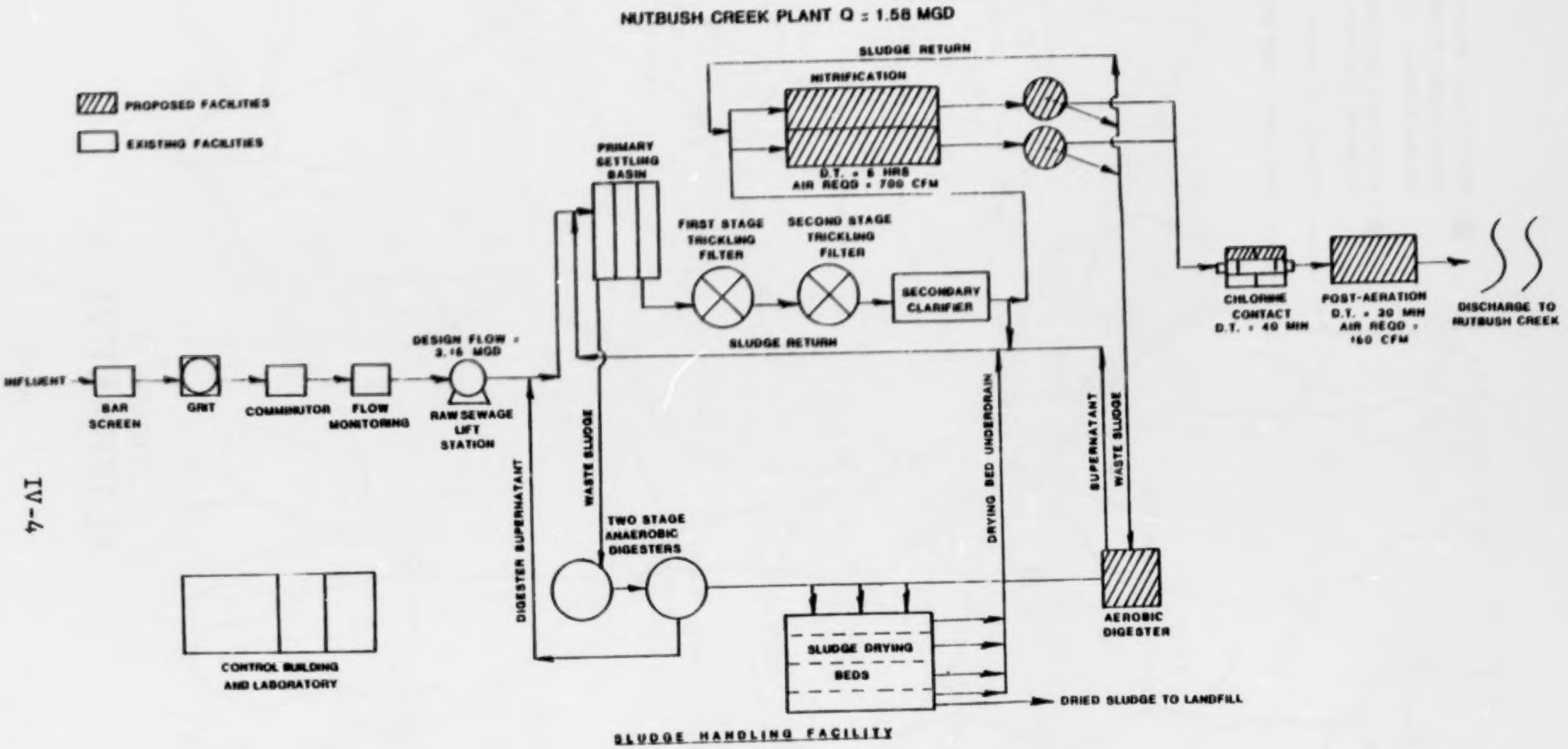

NUTBUSH CREEK PLANT Q = 1.58 MGD
PROPOSED FACILITIES
EXISTING FACILITIES
INFLUENT
BAR SCREEN
GRIT
COMMINUTOR
FLOW MONITORING
DESIGN FLOW = 3.16 MGD
RAW SEWAGE LIFT STATION
PRIMARY SETTLING BASIN
FIRST STAGE TRICKLING FILTER
SECOND STAGE TRICKLING FILTER
SECONDARY CLARIFIER
SLUDGE RETURN
NITRIFICATION
D.T. = 6 HRS
AIR REQD = 700 CFM
SLUDGE RETURN
CHLORINE CONTACT
D.T. = 40 MIN
POST-AERATION
D.T. = 30 MIN
AIR REQD = 160 CFM
DISCHARGE TO NUTBUSH CREEK
WASTE SLUDGE
DIGESTER SUPERNATANT
TWO STAGE ANAEROBIC DIGESTERS
DRYING BED UNDERDRAIN
SUPERNATANT
WASTE SLUDGE
AEROBIC DIGESTER
SLUDGE DRYING BEDS
DRIED SLUDGE TO LANDFILL
SLUDGE HANDLING FACILITY
CONTROL BUILDING AND LABORATORY

FIGURE IV - 2 IMPROVED NUTBUSH CREEK PLANT FOR ALTERNATIVE A

Additionally, Alternative A recommends a new 2.12 MGD facility on Sandy Creek below Southerland's Pond. Effluent limitations for this facility can be attained with preliminary treatment with flow measuring, two-stage aeration for BOD and SS reduction and nitrification with each stage followed by secondary clarification, fine solids settling for further BOD and SS removal, and final chlorination and post aeration before final discharge into Sandy Creek. Biological sludge can be processed in a new aerobic digester and air-dried on sand drying beds before ultimate disposal at the existing landfill site. A general layout of the proposed facility is presented in Figure IV-3.

Alternative A will require the construction of a pumping station at the Red Bud Creek wastewater treatment plant site to transfer wastewater to the Sandy Creek basin. An additional pumping station at the confluence of Sandy Creek and Martin's Creek should be constructed to transfer 2.12 MGD of wastewater to the new facility. Additionally, this alternative requires approximately 43,200 lineal feet of gravity sewer and approximately 38,250 lineal feet of force main.

Maintenance and operation of the facilities proposed under Alternative A will require approximately eleven personnel including one supervisor, one laboratory technician or chemist, one yardkeeper, and eight plant operators, i.e., four at each plant.

2. Alternative B

Alternative B recommends abandoning the two existing wastewater treatment facilities and constructing a single 3.70 MGD facility on Sandy Creek below Southerland's Pond. An illustration of this alternative, including the general location of major interceptors and collectors, is presented in Figure IV-4.

SANDY CREEK PLANT
Q = 2.12 MGD

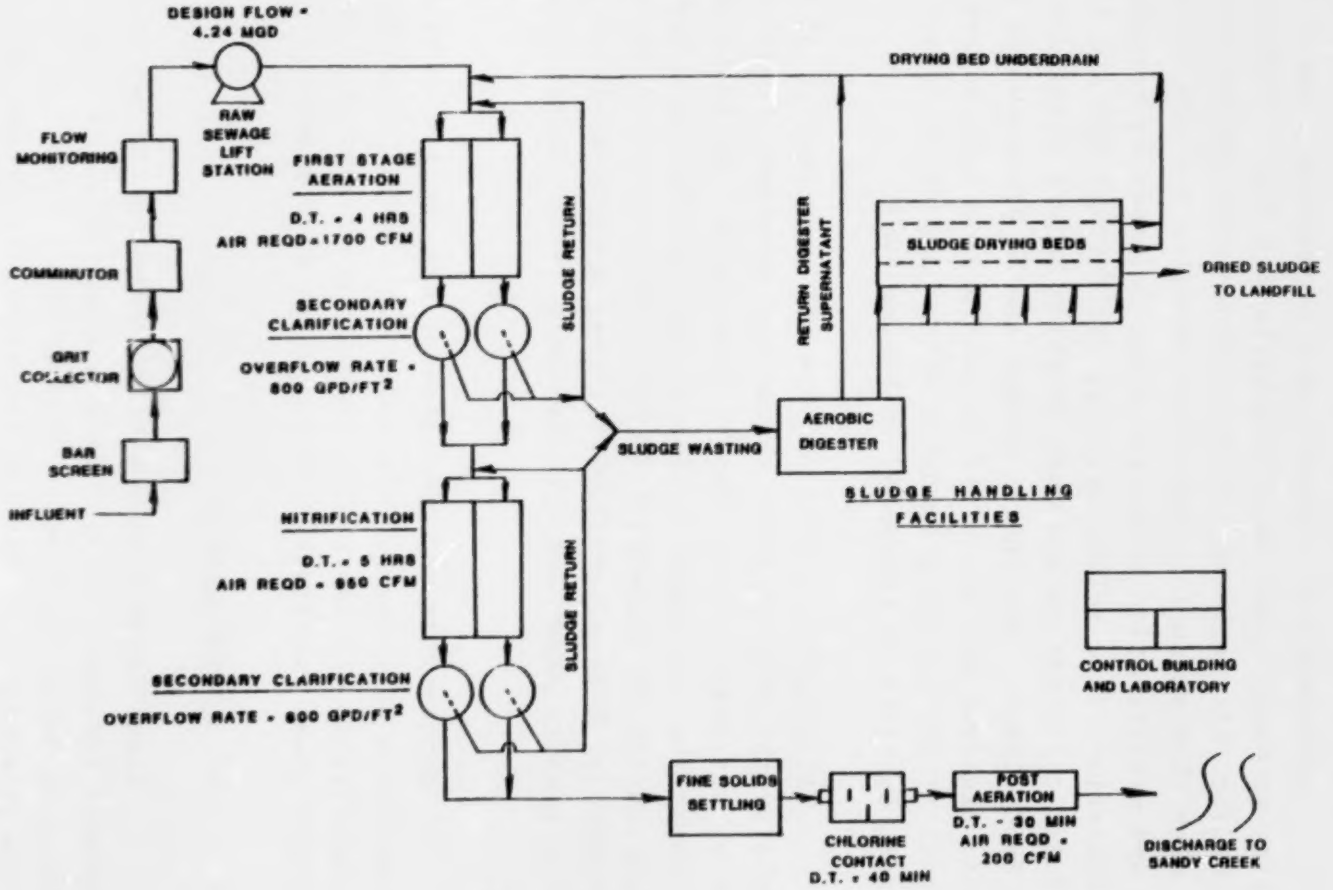

DESIGN FLOW = 4.24 MGD
RAW SEWAGE LIFT STATION
FLOW MONITORING
COMMINUTOR
GRIT COLLECTOR
BAR SCREEN
INFLUENT
FIRST STAGE AERATION
D.T. = 4 HRS
AIR REQD = 1700 CFM
SECONDARY CLARIFICATION
OVERFLOW RATE = 800 GPD/FT²
SLUDGE RETURN
NITRIFICATION
D.T. = 5 HRS
AIR REQD = 950 CFM
SLUDGE RETURN
SECONDARY CLARIFICATION
OVERFLOW RATE = 800 GPD/FT²
SLUDGE WASTING
AEROBIC DIGESTER
RETURN DIGESTER SUPERNATANT
DRYING BED UNDERDRAIN
SLUDGE DRYING BEDS
DRIED SLUDGE TO LANDFILL
SLUDGE HANDLING FACILITIES
CONTROL BUILDING AND LABORATORY
FINE SOLIDS SETTLING
CHLORINE CONTACT
D.T. = 40 MIN
POST AERATION
D.T. = 30 MIN
AIR REQD = 200 CFM
DISCHARGE TO SANDY CREEK

FIGURE IV - 3 NEW SANDY CREEK PLANT FOR ALTERNATIVE A

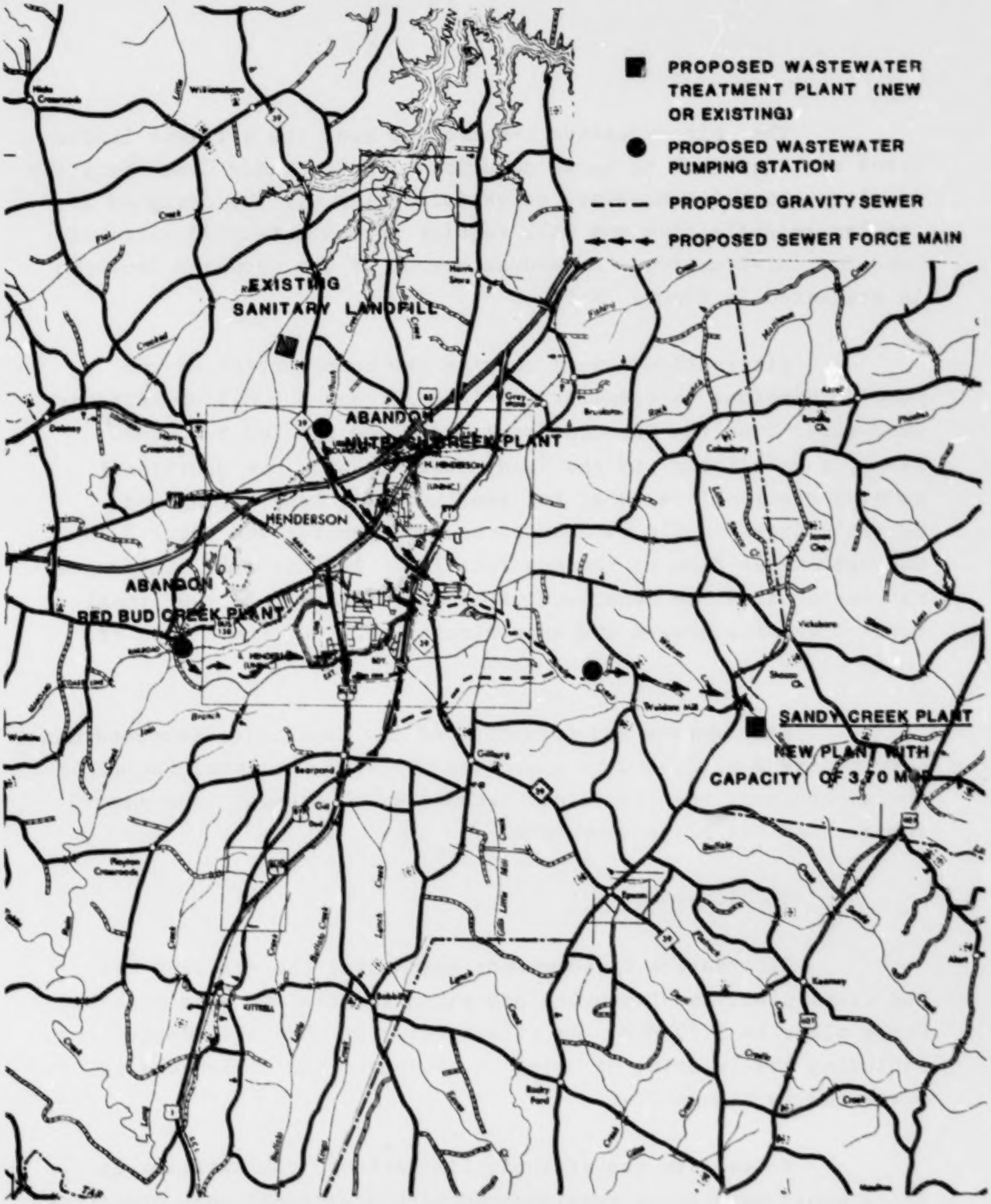

■ PROPOSED WASTEWATER TREATMENT PLANT (NEW OR EXISTING)
● PROPOSED WASTEWATER PUMPING STATION
– – – PROPOSED GRAVITY SEWER
→→→ PROPOSED SEWER FORCE MAIN
EXISTING SANITARY LANDFILL
ABANDON NUTBUSH CREEK PLANT
HENDERSON
N. HENDERSON
ABANDON RED BUD CREEK PLANT
SANDY CREEK PLANT
NEW PLANT WITH CAPACITY OF 3.70 MGD

FIGURE IV-4

ALTERNATIVE B

The unit processes required to meet the effluent limitations are identical to those described for the Sandy Creek facility in Alternative A. However, these facilities will be designed for the larger daily flow and will require approximately 20 acres of land for construction. A general layout of the proposed facility is presented in Figure IV-5.

Alternative B will require the construction of two pumping stations to transfer the 1.58 MGD and 0.6 MGD of tributary wastewater from the Nutbush Creek basin and the Red Bud Creek basin, respectively, to the Sandy Creek basin. One additional pumping station located at the confluence of Sandy Creek and Martin's Creek should be constructed to transfer the total 3.70 MGD wastewater flow to the new facility. Additionally, this alternative requires the construction of approximately 52,700 lineal feet of gravity sewers and approximately 52,250 lineal feet of force mains.

Maintenance and operation of the facilities proposed under Alternative B will require approximately nine personnel including one supervisor, one laboratory technician or chemist, one yardkeeper, and six plant operators.

3. Alternative C

Alternative C recommends abandoning the existing Red Bud Creek plant and improving and expanding the existing Nutbush Creek plant to 3.70 MGD. An illustration of this alternative including the location of major interceptors and collectors is presented in Figure IV-6.

To satisfy the effluent limitations, the existing facilities would have to be supplemented with additional unit processes including an aeration system followed by secondary clarification

SANDY CREEK PLANT
Q = 3.70 MGD

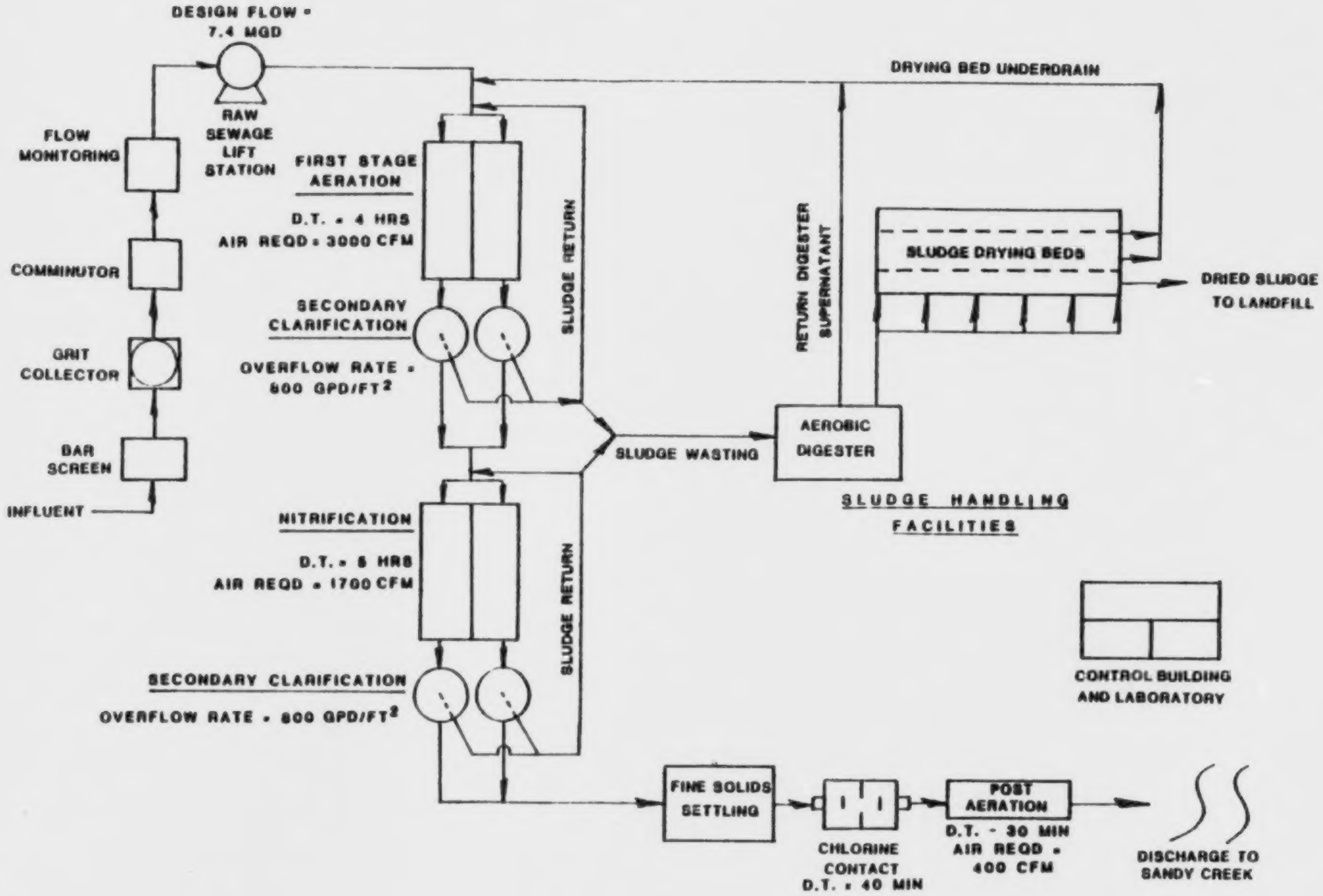

DESIGN FLOW = 7.4 MGD
RAW SEWAGE LIFT STATION
FLOW MONITORING
COMMINUTOR
GRIT COLLECTOR
BAR SCREEN
INFLUENT
FIRST STAGE AERATION
D.T. = 4 HRS
AIR REQD = 3000 CFM
SECONDARY CLARIFICATION
OVERFLOW RATE = 600 GPD/FT2
NITRIFICATION
D.T. = 6 HRS
AIR REQD = 1700 CFM
SECONDARY CLARIFICATION
OVERFLOW RATE = 800 GPD/FT2
SLUDGE RETURN
SLUDGE RETURN
SLUDGE WASTING
DRYING BED UNDERDRAIN
RETURN DIGESTER SUPERNATANT
SLUDGE DRYING BEDS
DRIED SLUDGE TO LANDFILL
AEROBIC DIGESTER
SLUDGE HANDLING FACILITIES
CONTROL BUILDING AND LABORATORY
FINE SOLIDS SETTLING
CHLORINE CONTACT D.T. = 40 MIN
POST AERATION
D.T. = 30 MIN
AIR REQD = 400 CFM
DISCHARGE TO SANDY CREEK

FIGURE IV - 5 NEW SANDY CREEK PLANT FOR ALTERNATIVE B

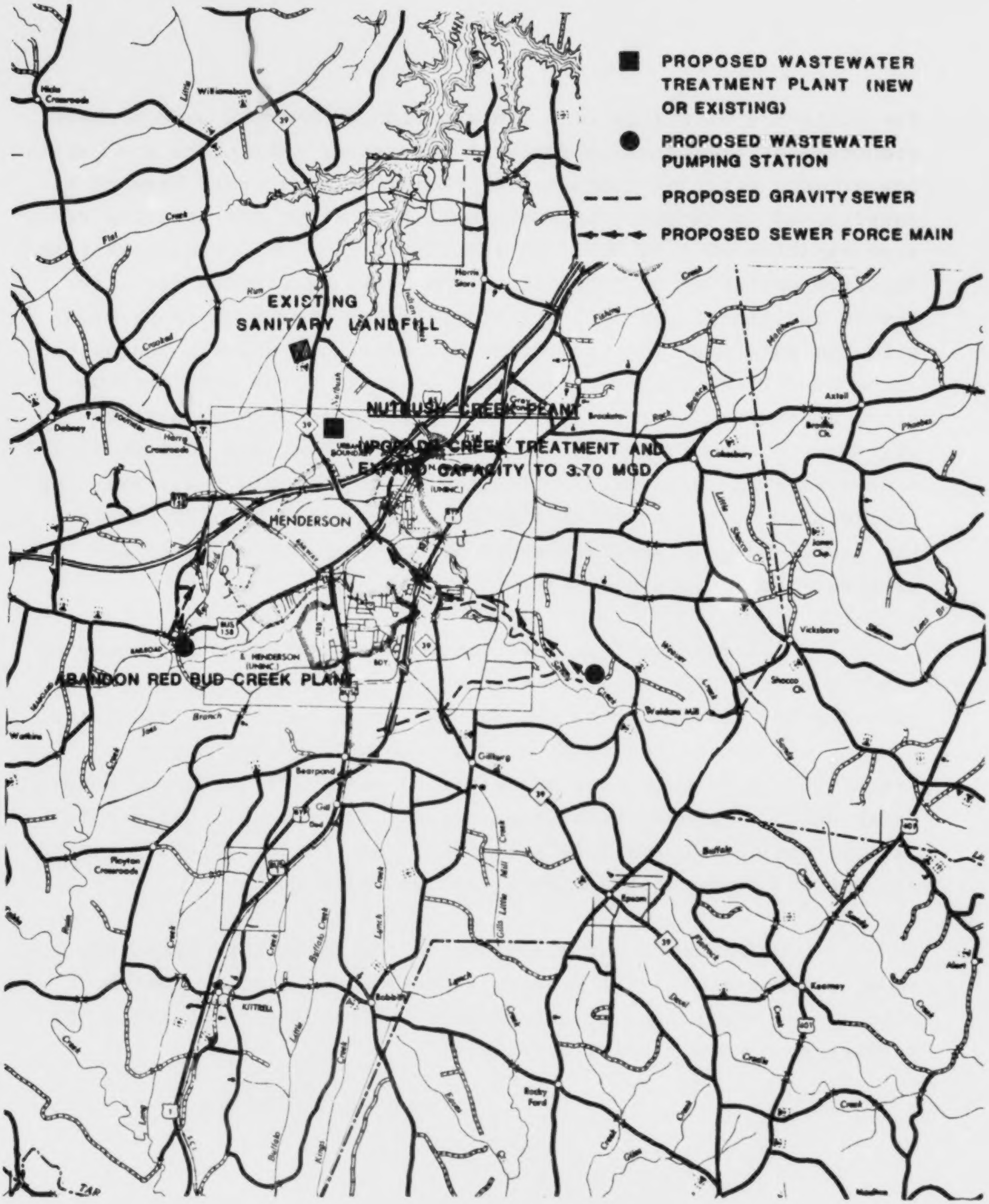

■ PROPOSED WASTEWATER TREATMENT PLANT (NEW OR EXISTING)
● PROPOSED WASTEWATER PUMPING STATION
PROPOSED GRAVITY SEWER
PROPOSED SEWER FORCE MAIN
EXISTING SANITARY LANDFILL
NUTBUSH CREEK PLANT
UPGRADE CREEK TREATMENT AND EXPAND CAPACITY TO 3.70 MGD
HENDERSON
ABANDON RED BUD CREEK PLANT

FIGURE IV-6
ALTERNATIVE C

for achieving nitrification. In addition to the new unit process required for treatment improvement, processes similar to the existing primary settling tanks and trickling filters would have to be constructed to support the additional flow above the existing design capacity of 1.84 MGD. An additional 1.86 MGD primary settling facility operating in parallel to the existing similar facility and an additional 1.86 MGD trickling filter operating in parallel with the existing two-stage high-rate trickling filters can be constructed for the required increased capacity. The existing two-stage anaerobic digesters will be supplemented with an aerobic digester to support the increased sludge volume, and supplemental sand-drying bed area will be required. Additionally, all existing preliminary treatment facilities should be replaced with new larger facilities. A general layout of the proposed improved and expanded facility is presented in Figure IV-7.

Alternative C will require the construction of a pumping station at the Red Bud Creek wastewater treatment plant site for transferring wastewater to the Nutbush Creek basin. An additional pumping station at the confluence of Sandy Creek and Martin's Creek will be required for transferring wastewater from the Sandy Creek basin to the Nutbush Creek basin. Additionally, this alternative requires approximately 41,800 lineal feet of gravity sewers and approximately 41,100 lineal feet of force mains.

Maintenance and operation of the facilities proposed under Alternative C will require approximately nine personnel including one supervisor, one laboratory technician or chemist, one yardkeeper, and six plant operators.

NUTBUSH CREEK PLANT Q = 3.70 MGD

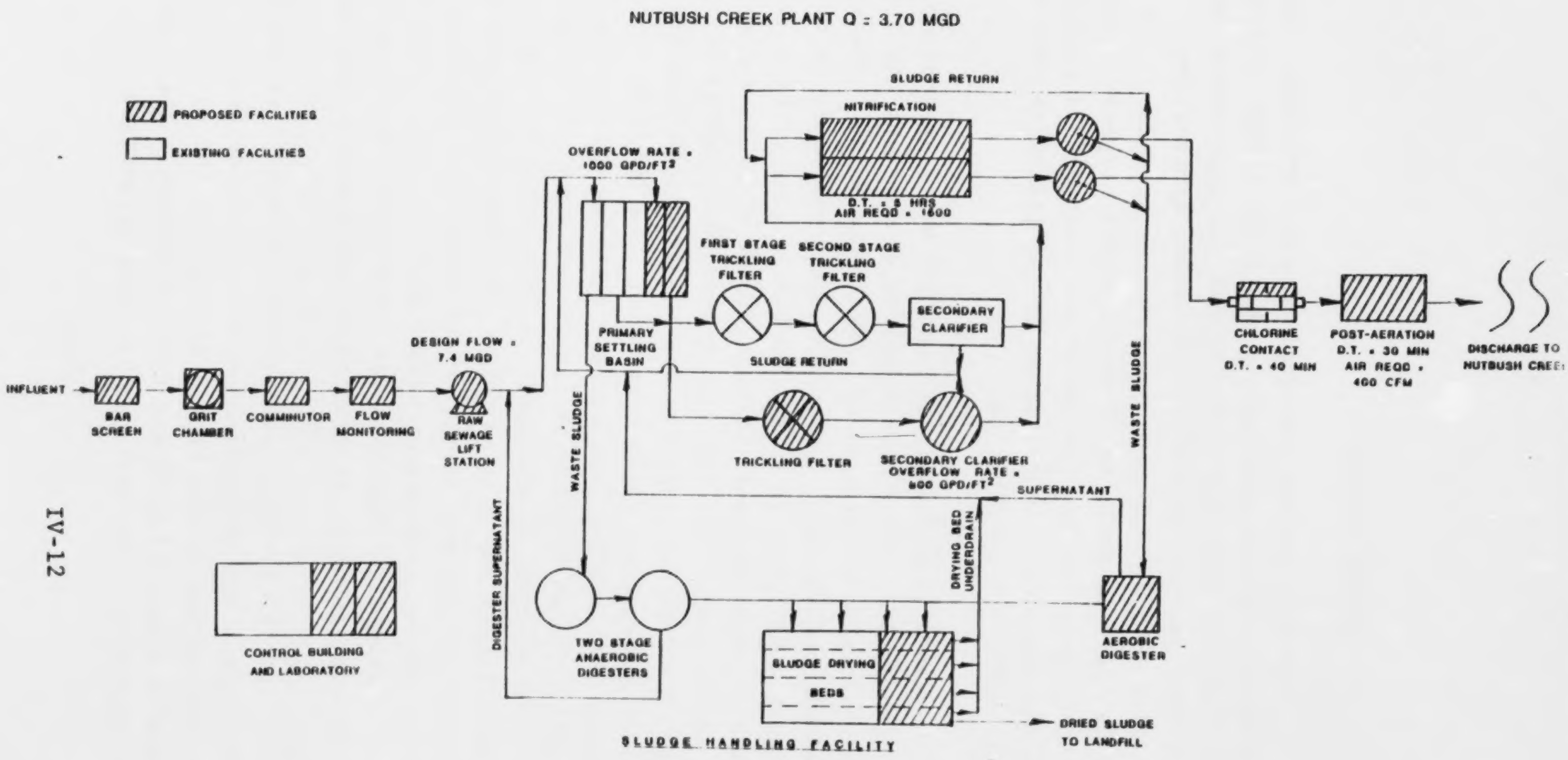

▨ PROPOSED FACILITIES
☐ EXISTING FACILITIES
INFLUENT
BAR SCREEN
GRIT CHAMBER
COMMINUTOR
FLOW MONITORING
DESIGN FLOW = 7.4 MGD
RAW SEWAGE LIFT STATION
DIGESTER SUPERNATANT
OVERFLOW RATE = 1000 GPD/FT²
PRIMARY SETTLING BASIN
WASTE SLUDGE
SLUDGE RETURN
NITRIFICATION
D.T. = 5 HRS
AIR REQD = 1600
FIRST STAGE TRICKLING FILTER
SECOND STAGE TRICKLING FILTER
SECONDARY CLARIFIER
SLUDGE RETURN
TRICKLING FILTER
SECONDARY CLARIFIER OVERFLOW RATE = 600 GPD/FT²
SUPERNATANT
DRYING BED UNDERDRAIN
WASTE SLUDGE
AEROBIC DIGESTER
CHLORINE CONTACT D.T. = 40 MIN
POST-AERATION D.T. = 30 MIN AIR REQD = 400 CFM
DISCHARGE TO NUTBUSH CREE
CONTROL BUILDING AND LABORATORY
TWO STAGE ANAEROBIC DIGESTERS
SLUDGE DRYING BEDS
SLUDGE HANDLING FACILITY
DRIED SLUDGE TO LANDFILL

FIGURE IV - 7 IMPROVED AND EXPANDED NUTBUSH CREEK PLANT FOR ALTERNATIVE C

C. Sludge Disposal

The only process residual from any treatment alternative that requires off-site disposal is the dried sludge periodically scraped from the sand beds. The sludge, in approximate amounts of five tons per day (Alternative A: 4.76; Alternative B: 4.44; Alternative C: 5.20 tons per day), will be trucked to the Vance County Sanitary Landfill No. 2 for ultimate disposal. This is the current practice for the Henderson treatment facilities, although the amount of sludge currently landfilled is considerably smaller, about 0.6 tons per day.

Vance County Sanitary Landfill No. 2 is just west of State Highway 39, approximately two miles north of its intersection with Interstate Highway 85 (See Figure V-10). The site lies within the drainage basin of a large tributary to Crooked Run, whose confluence is in the backwater area of Kerr Reservoir; the site is very near the drainage divide with the Nutbush Creek basin to the east. The contractor-operated landfill utilizes the trench method of disposal with refuse placed near the bedrock interface and covered daily with soil. The landfill is about two years old, but the unexpectedly shallow soil conditions probably limit the useful life of the 40-acre tract to about two more years. Daily input is estimated to be about 1,000 cubic yards, or approximately 700 tons per day. The composition of this refuse is chiefly garbage and rubbish; some industrial solid waste, such as broken glass, spun glass, broken pallets, cloth scraps, and soda ash mixed with sand, is also landfilled. No significant problems with leachate production or vectors have been reported.

At the present time, several alternatives for future landfill sites are under consideration by Vance County. These include leasing one or two tracts adjacent to the existing landfill, and also purchase of a larger tract elsewhere. The locations of other potential sites have not yet been determined.

V. ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTIONS

A. General

The Alternatives A, B, and C were analyzed to determine their primary and secondary impacts and the short-term or long-term nature of these impacts. Some impacts described in this chapter, including primary water quality impacts and numerous secondary impacts related to the growth of the Henderson urban area, address conditions that will prevail only at the end of the 20-year design period. Initial operational impacts will be considerably less than these ultimate conditions, but they will gradually increase to the level of effect described herein. The impact analysis focuses on the wastewater treatment plants and systems described in Chapter IV.

To facilitate reference and integration with results presented in Chapter II, Existing Environment, the discussion of impacts follows the same outline as Chapter II. Impacts of all three proposed actions, and especially differential impacts, are discussed for each environmental parameter or category. Because there are more similarities than differences in impacts among the alternatives, many impacts of the alternatives for a category are collectively described. Only those impacts particular to a specific alternative are discussed under separate subheadings.

Some impacts have been evaluated using quantitative or semi-quantitative methods, and some have been assessed by using a data base that is too detailed to incorporate into the Draft Statement. These supplementary descriptions, data, concept formulations, and rationale are included in the Technical Reference Document (RA-R-276) generated by the evaluation process.

B. Natural Environment

The natural environment is comprised of those areas of the total environment that are external to man and his social organization. For consistency with Chapter II, impacts of the proposed actions upon the natural environment are presented in two major components, physical and biological.

1. Physical Components

Impacts accruing from implementation of the proposed actions upon physical components of the environment, atmosphere, land, water and land/water interface are described in the subsections that follow.

a. Air Quality

Primary air quality effects of Alternatives A, B, and C will be minor. During construction of the wastewater treatment facility on Sandy Creek and upgrading Nutbush Creek facilities, various minor air pollutant emissions will occur. Fugitive dust emissions may occur during site preparation and during construction activities. Recent studies have shown that dust generated by construction activities is a function of soil type, climate, and extent of construction activities (CO-352). Due to the size and duration of the proposed project, it will not cause appreciable fugitive dust. Another result of construction activities will be combustion air pollutants emitted from gasoline- and diesel-fueled equipment operating at the construction sites. Again, the impact of these emissions will be minor.

Impact on air quality of system operation will also be minor. Various electrically-operated equipment within the system will not produce gaseous emissions.

Secondary air quality effects are, in general, related to the amount of population growth and possible industrial expansion occurring because of expanded and improved waste treatment facilities. Specific effects of growth on air quality are difficult to predict quantitatively. However, in light of the good air quality in Henderson, it can be assumed that any future sources of air pollution will not result in violation of national ambient air quality standards.

b. Odor

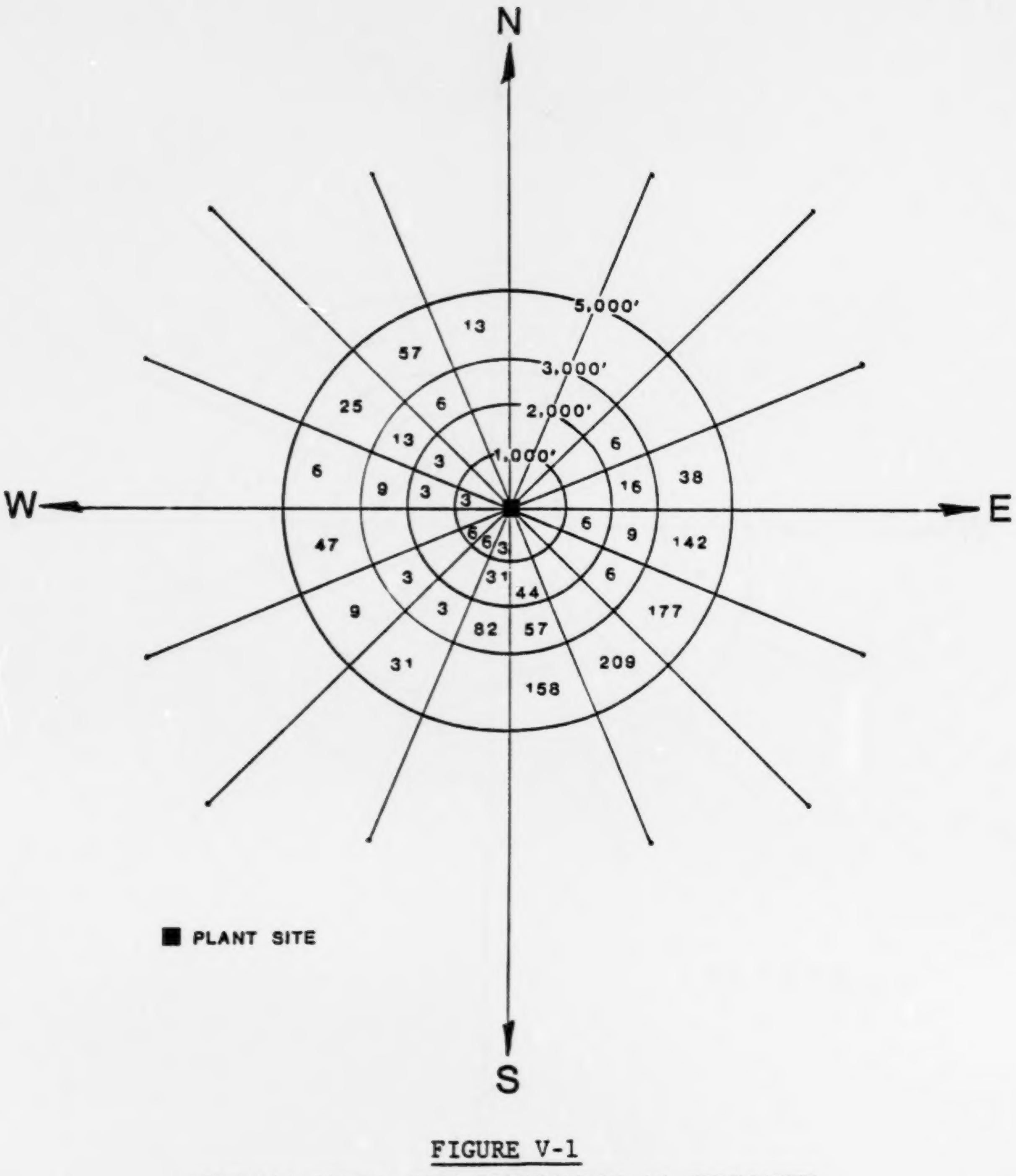
No substantial community odor problems of either primary or secondary types are anticipated during normal operation of the proposed wastewater facilities in any of the alternatives. However, all sewage treatment plants and transmission facilities have the potential for generating offensive odors to a minor degree; this is particularly true for those components that operate, either normally or abnormally, under anaerobic conditions. Such facilities include anaerobic digestors, other sludge handling facilities, pump stations, interim storage areas, and long force mains. Abnormal anaerobic conditions are more likely to occur during the warmer summer months. All systems contain a pump station at the existing Red Bud Creek plant. This station is the only pump station likely to have any negative impact, due to the proximity of future residential areas. Therefore, most concern with odor problems centers on the sewage treatment plants. In comparison, odors at all pump stations are judged to be of insignificant magnitude. It should also be noted that all alternatives have force mains that convert to gravity flow systems in populated areas; if anaerobic conditions are produced, odors may emanate from man-holes in these areas. However, generally collection and transport systems are designed to prevent odors.

To assess more quantitatively the relative negative impact of odors during extreme conditions on communities at the proposed treatment plant sites, hypothetical unit odor "doses" for areas within one mile of the sites were computed. These factors relate three parameters: the relative odor concentration downwind from the plant under Gaussian dispersion, the number of dwelling units (and thereby population) in 16 radial sectors at 1,000-, 2,000-, 3,000-, and 5,000-foot intervals (Figures V-1 and V-2), and the average summertime frequency of wind direction. The magnitude of the dose factor indicates the relative sensitivity of that area on the basis of relative odor concentration, population, and time.. These dose factors are shown in Figure V-3 and V-4 as numbers in sectors defined by direction and radial distances.

A beneficial impact of any of the alternatives is the elimination of the necessity for package treatment facilities to provide wastewater treatment, particularly in the Red Bud and Sandy Creek basins. These small, usually inefficient package treatment facilities are notorious odor sources if improperly maintained. Their use, along with individual septic tanks, would be nearly certain if new municipal facilities were not constructed.

Alternative A

The Nutbush Creek plant, equipped with uncontrolled anaerobic digesters and a partly open sludge transfer system, potentially will emit more odors than the Sandy Creek plant in this alternative. Inspection of the figures of odor doses indicates, furthermore, that the overall relative sensitivity of community impacts is much higher for the Nutbush Creek plant than the Sandy Creek site. The more significant odor problems at both locations will likely be those that are exacerbated by higher temperatures during summer months. However, prevailing summer winds are from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25
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16
38
6
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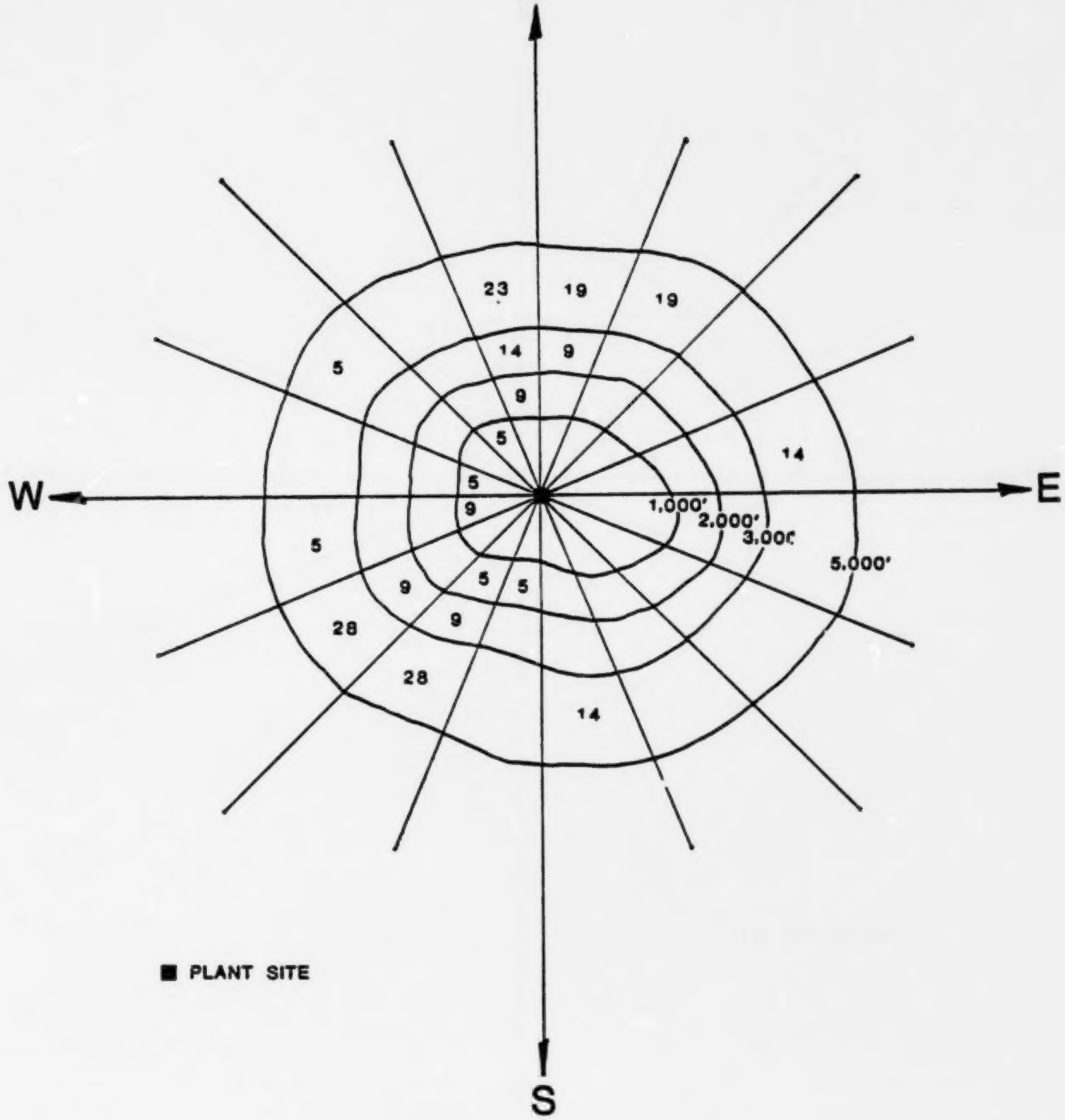
142
47
6
6
3
3
31
44
6
177
9
3
82
57
31
209
158
■ PLANT SITE

FIGURE V-1

NUTBUSH CREEK SITE POPULATION AS INDICATED BY PHOTOINTERPRETATION (Radial Distances from Anaerobic Digesters)



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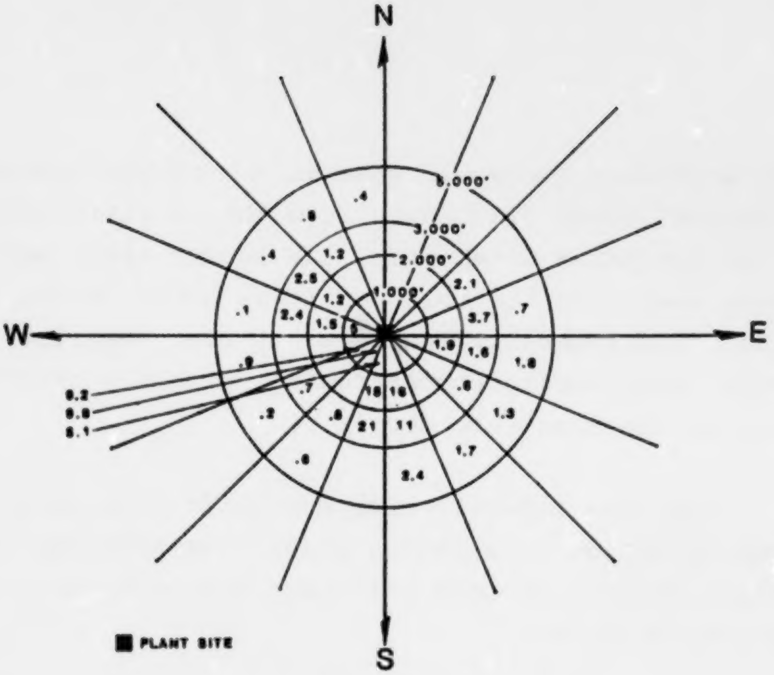
23
19
19
14
9
5
9
5
14
5
9
1,000'
2,000'
3,000'
5,000'
5
9
5
5
28
9
28
14
■ PLANT SITE

FIGURE V-2

PROPOSED SANDY CREEK SITE POPULATION AS INDICATED BY PHOTOINTERPRETATION
(Radial Distances from Plant Boundaries)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.4
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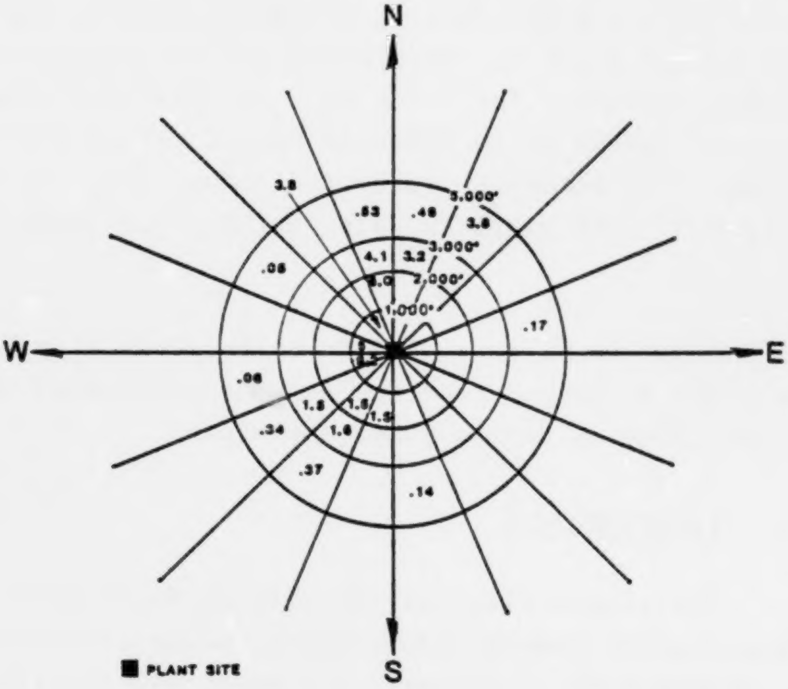
1
2.1
3.7
.7
1.9
1.6
1.8
.9
9.2
9.8
8.1
.7
18
16
.8
1.3
.2
.8
21
11
1.7
.6
2.4
PLANT SITE

FIGURE V-3
NUTBUSH CREEK SITE
RELATIVE ODOR DOSAGES ON AN AVERAGE SUMMER BASIS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3.8
5,000'
.53
.49
3.8
3,000'
.05
4.1
3.2
3.0
2,000'
1,000'
.17
.06
1.8
1.5
1.5
.34
1.6
.37
.14
PLANT SITE

FIGURE V-4
SANDY CREEK SITE
RELATIVE ODOR DOSAGES ON AN AVERAGE SUMMER BASIS

south to southwest and would generally transport odors produced at the Nutbush Creek plant away from the sensitive Henderson urban areas. At the Sandy Creek site, the summer winds would also transport odors away from the most sensitive areas in the vicinity of the plant. The generally low level of odor emissions at the Sandy Creek site, even during summer months, probably restricts the impact area to the plant boundaries.

Positive impacts which accrue in this alternative include the reduction of existing minor odor problems at the Nutbush Creek plant because of more efficient treatment and operation in its upgraded condition.

Alternative B

Owing to the sparseness and distribution of population around the site and the aerobic treatment process employed, odors from the single plant on Sandy Creek are not anticipated to be a significant problem. The force main may generate some odors, but they are not likely to be detected beyond radial distances of 1,000 feet. The comments concerning summertime odor distribution for the Sandy Creek plant in Alternative A also apply to Alternative B.

Positive impacts similar to those in Alternative A also hold for B, except that the new odor source at the Nutbush Creek plant site is only a pumping station.

Alternative C

The single plant at the Nutbush Creek site probably will have a minor adverse odor impact on the community. The higher loading rate to the existing anaerobic digesters will likely produce periodic but tolerable odor emissions. The distribution of sensitive areas suggests that the possibility of odor complaints cannot be dismissed as remote, even though odor episodes will likely be rare. The comments concerning summertime odor distribution for the Nutbush Creek plant of Alternative A are also applicable to Alternative C.

c. Noise

(1) Methodology and Criteria

The methodology and criteria for predicting human and animal responses to noise emissions from construction and operation of the proposed wastewater treatment facilities are summarized in the paragraphs that follow.

Criteria documented by the Environmental Protection Agency in "Information on Levels of Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety" were used as the basis for estimating the effects of noise from construction and operation of wastewater treatment facilities (EN-108). In development of the criteria, EPA did not make a distinction between health and welfare but defined health as the World Health Organization does: "a total physical, physiological, and psychological well-being of the individual." Therefore, spoken communication, sleep disturbance and hearing hazards are aspects of health.

To quantitatively measure the impact of noise, EPA recommends the use of a measure, L_{dn}, the long-term equivalent A-weighted sound level with an adjustment to account for differences in response during daytime and nighttime periods. Mathematically, L_{dn} is expressed as shown in Equation 1.

$$L_{dn} = 10 \log \frac{1}{24} \left[15 \left(10^{Ld/10}\right) + 9 \left(10^{\frac{Ln+10}{10}}\right) \right] \text{ dB} \qquad (1)$$

where:

$L_d = L_{eq}$ for daytime (0700 hours to 2200 hours)

$L_n = L_{eq}$ for nighttime (2200 hours to 0700 hours)

Equation 1 essentially states that a 10 dB penalty is applied for nighttime operations. For the purposes of this assessment, it may be assumed that L_{eq} is measured or predicted sound level approximated by a normal distribution having a standard deviation equal to zero and that these sound levels are those that are exceeded 50% of the time. Measured or predicted levels can be considered to be equal to L_{eq} (EN-108).

Table V-1 summarizes noise level limits in terms of L_{dn} and L_{eq} considered essential to protect public welfare and safety. Note that L_{dn} = 55 dB and L_{eq} = 55 dB are values that are applicable to the outdoor areas that are likely to be impacted by construction and operation of the wastewater treatment facilities. This table serves as the basis for general assessment of environmental noise as required by this program. Further refinement of these guidelines can be achieved by considering the communication factors discussed below.

TABLE V-1
SOUND LEVELS REQUIRED TO PROTECT PUBLIC HEALTH AND WELFARE

EFFECT	LEVEL	AREA
Hearing Loss	$L_{eq(24)} \leq 70$ dB	All Areas
Outdoor activity interference and annoyance	$L_{dn} \leq 55$ dB	Outdoor and residential areas, farms and other outdoor areas where people spend widely varying amounts of time, and other places in which quiet is a basis for use.
	$L_{eq(24)} \leq 55$ dB	Outdoor areas where people spend limited amounts of time such as school playgrounds, etc.
Indoor activity interference and annoyance	$L_{dn} \leq 45$ dB	Indoor residential areas.
	$L_{eq(24)} \leq 45$ dB	Other indoor areas with human activities such as schools, etc.

Source: EN-108

The ability to communicate effectively depends upon the presence and level of ambient or "masking" noise. The values of Table V-2 illustrate the person-to-person separation that will permit 95% speech intelligibility in the presence of different A-weighted sound levels (dBA) and vocal efforts. The data are representative of male voices with individuals face-to-face outdoors.

Additional evaluation may be made by considering the effect of noise upon communication by telephone. The quality of telephone usage in the presence of a steady-state masking noise may be obtained from Table V-3.

TABLE V-2

MAXIMUM A-WEIGHTED SOUND LEVELS THAT WILL PERMIT UNDERSTANDABLE SPOKEN COMMUNICATION FOR VOICE LEVELS AND LISTENER DISTANCES SHOWN

DISTANCE (feet)	AMBIENT SOUND LEVEL IN dBA			
	Vocal Effort			
	Low	Normal	Raised	Very Loud
1	60	66	72	78
2	54	60	66	72
3	50	56	62	68
4	48	54	60	66
5	46	52	58	64
6	44	50	56	62
12	38	44	50	56

TABLE V-3

QUALITY OF TELEPHONE USAGE IN THE PRESENCE OF STEADY-STATE MASKING NOISES

NOISE LEVEL (dBA)	TELEPHONE USAGE QUALITY
30-50	Satisfactory
50-65	Slightly Difficult
65-75	Difficult
Above 75	Unsatisfactory

The change in ambient sound level is an important factor in assessing the impact from added noise sources. It is possible to just detect a 2-3 dBA change while a 5 dBA change is readily apparent. A 10-decibel increase is judged by most people as a doubling of the loudness of sound, and each 10-decibel increase is perceived as doubling the loudness.

The effects of noise upon wildlife and domestic animals are not well understood. Studies of animals subjected to varying noise exposures in laboratories have demonstrated physiological and behavioral changes, and it may be assumed that these reactions are applicable to wildlife. However, no scientific evidence currently correlates the two. It is known that large animals adapt quite readily to high sound levels. Conversely, it has been demonstrated that loud noise disrupts brooding in poultry and consequently can affect egg production.

The major effect of noise on wildlife is related to the use of auditory signals. Acoustic signals are important for survival in some wildlife species. Probably the most important effect is related to the prey-predator situation. An animal that relies on its ears to locate prey and an animal that relies on its ears to detect predators are both impaired by intruding noise. In addition, the reception of auditory mating signals could be limited, and reproduction could be affected. Distress or warning signals from mother animals to infants (or vice versa) or within groups of social animals could be masked and such masking could lead to increased mortality. There are clues that short-term high noise levels may startle wild game birds and stop the brooding cycle for an entire season (ME-050).

In this study, noise levels were predicted using a simple model that incorporates measured data from major sound sources and standard acoustical field equations. Results will be presented in terms of L_{dn} as a function of distance from noise sources. Figure V-5 illustrates the basis for general assessment of expected community response to various levels of noise.

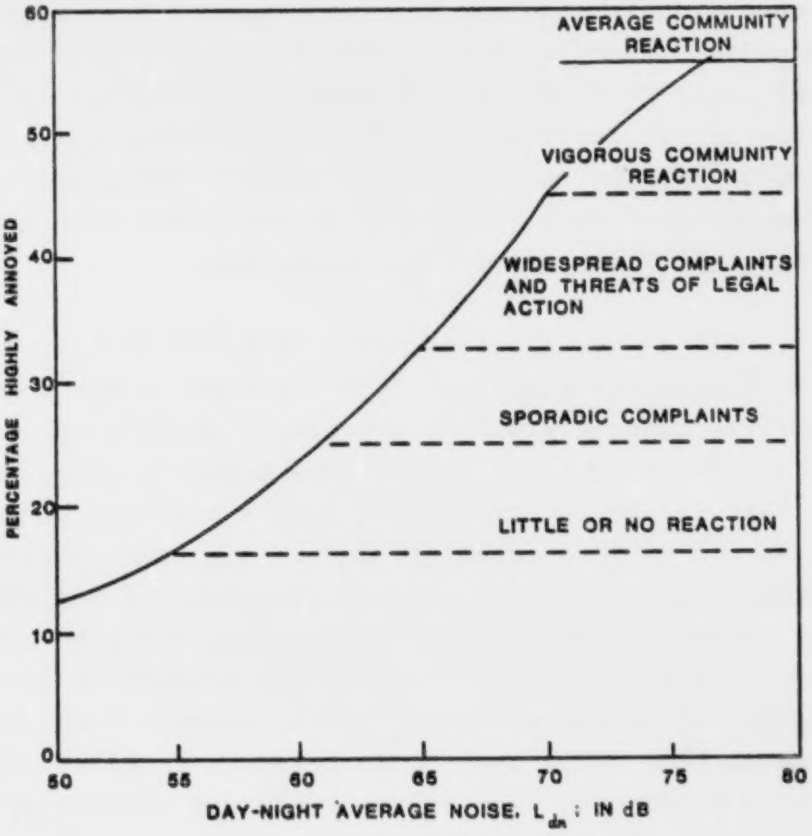


FIGURE V-5

EXPECTED COMMUNITY RESPONSE TO VARIOUS LEVELS OF NOISE

(2) Noise Impacts

General

Noise associated with the construction and operation of all alternative systems can be described as short-term and long-term. Short-term noise is that which will occur during the construction phases for sewer interceptors and sewage treatment plants (STP's); long-term noise results from operation of the STP's.

Short-term noise is caused by activity of construction equipment along and near interceptors and at each STP location. To ascertain possible adverse effects from this activity, a complement of construction equipment was assumed. Based on the radiated sound pressure level of each equipment item, predictions were performed using standard acoustical field equations and assuming worst-case mitigating factors such as a standard day, no attenuating barriers (such as trees) and acoustically-untreated noise sources. This approach yields results that may be considered as a worst-case noise condition and will provide clues about the adverse impact that may be caused.

Construction of an interceptor requires equipment that is standard in earth-working and pipeline machinery inventories. A right-of-way (ROW) is cleared with dozers and debris is removed with front-loaders and dump trucks. Crews with chain-saws are active for short periods in timbered areas. A ditch-digger with back hoes follows; rock drills and blasting may be required in hard-rock areas. The pipe laying activity requires heavy trucks, a crane, dozers, and other equipment. Essentially these same types of equipment will be required for construction of the STP. Typical sound level spectra for the above equipment items are given in Table V-4 (BO-054).

TABLE V-4

SOUND PRESSURE LEVEL IN dB AT A DISTANCE OF 50 FEET FROM VARIOUS TYPES OF CONSTRUCTION EQUIPMENT

	Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	dBA
Dozer (Soil 270 hp)	75	73	80	77	75	72	65	61	77
Dump Truck	73	78	80	75	67	65	58	50	72
Back-Hoe/Front Loader	73	73	73	73	73	68	62	58	75
Rock Drill	86	94	91	90	93	93	91	89	98
Crane	83	91	88	87	83	77	71	65	86
Concrete Mixer	70	70	70	70	70	63	57	51	72

Assuming that the construction activity occurs from 8:00 a.m. to 5:00 p.m. and that ambient sound levels are 50 dBA from 5:00 p.m. to 11:00 p.m. and 45 dBA until 8:00 a.m., the values of L_{dn} in Table V-5 were computed as a function of distance for each type of equipment.

TABLE V-5

L_{dn} IN dB AS A FUNCTION OF DISTANCE FROM VARIOUS TYPES OF CONSTRUCTION EQUIPMENT

	Distance from Source (Feet)				
	250	500	750	1000	2000
Dozer	60	56	54	-	-
Dump Truck	56	-	-	-	-
Backhoe	59	55	-	-	-
Rock Drill	81	75	73	70	62
Crane	70	63	60	58	-
Concrete Mixer	57	-	-	-	-

Referring to the criteria of Figure V-5 and L_{dn} = 55 dB as the threshold value for creating annoyance, it is seen that operation of certain equipment items will be a source of concern at certain distances. These are summarized in Table V-6.

TABLE V-6

DISTANCES FROM CONSTRUCTION EQUIPMENT AT WHICH ANNOYANCE OCCURS DUE TO SOUND LEVEL

Equipment Hem	Distance (H)
Dozer	100
Dump truck	100
Backhoe	500
Rock Drill	>2,000
Crane	2,000
Concrete Mixer	500

The actual sound levels depend upon ambient duty cycle and the number and mixture of types that are operating simultaneously. In general, however, mild adverse reaction may be expected during development of the ditch at a distance of up to about 700 feet due to noise caused by dozers, backhoes, and trucks. Laying the sewer pipe will cause a more severe impact, since noise from crane operations will dominate the noise field up to 2,000 feet. Where blasting is required, the rock drill operation will be a major noise source causing extreme annoyance up to distances of about 2,000 feet.

Without the presence of human receptors of noise, environmental impact of noise upon human activity will not exist. Construction of portions of the sewer mains for all alternatives will take place in populated areas, and many more people will be exposed to this construction noise than construction and operation noise at STP's. Construction noise can be better tolerated by human inhabitants than long-term noise because of its transient nature. This observation does not preclude the possibility of generating considerable adverse reaction, particularly with the higher noise offenders.

The length of time that such noise intrusion will occur is highly variable, depending upon soil conditions, accessibility, weather, and other factors. Assuming that approximately 3,000 feet of interceptor can be completed in a typical one-month period, the length of time a given group of residents will be affected can be estimated directly. As discussed previously, noise intrusion can be expected to cause adverse human reaction at distances typically up to about 1,000 feet from the center of construction activity. At a completion rate of 3,000 feet per month, such inhabitants could expect noise to be in excess of limiting threshold levels for a total time of two weeks to one month.

Construction or expansion of the STP's will take place over a period of about one year. Residents within 1,000 feet of these construction sites may suffer some mild degree of annoyance during the construction phase. The population distribution about the sites is presented in the preceding Figures V-1 and V-2. Aerial photography (1975) indicates about 20 people live within 1,000 feet of both the Nutbush and Sandy Creek plant sites, although some present residents adjacent to the Sandy Creek site are known to be moving away.

The impact of noise from construction upon wildlife is not considered serious. Inhabitants of a particular area will likely vacate it during construction more due to the activity than because of the increased noise. Birds and other animals are expected to return to the affected habitat after the activity ceases. Noise within 1,000 feet of STP's could affect birds and those other animals that rely upon auditory signals to find mates, stake out territories, recognize young, detect and locate prey, and evade predators. However, experience indicates that the type of animals in the area adapt quite readily to noise of the levels indicated. Therefore, the effect of construction noise on wildlife is not considered to be an appreciable problem.

Noise from operation of the STP's is likely to be higher for the Sandy Creek plant than the Nutbush Creek plant, although the difference is probably not substantial. In both plants, noise is caused primarily by equipment associated with the diffuser aeration system, and the difference between the plants is related to the different sizes and number of noise sources. Some water movement noise, splashing and bubbling, will be present but will not be of sufficient intensity to be audible above background levels beyond the plant boundary. Components of the aeration system include electric motors, blowers/compressors and control valves. In an acoustically-untreated condition they will generate sound pressure levels at 50 feet with the approximate spectrum shown in Table V-7.

TABLE V-7

SPECTRUM OF SOUND PRESSURE LEVELS FROM DIFFUSED AERATION SYSTEM

Frequency (Hz)	Sound Pressure Levels at 50 ft (dB)	Frequency (Hz)	Sound Pressure Levels at 50 ft (dB)
63	64	2000	84
125	59	4000	76
250	63	8000	69
500	67	dBA	86
1000	74		

Assuming that these sound pressure levels are constant for both daytime and nighttime periods, L_{dn} was computed as a function of distance from the center of each plant as shown in Table V-8.

TABLE V-8

L_{dn} AS A FUNCTION OF DISTANCE FROM SEWAGE TREATMENT PLANTS

Distance (ft)	L_{dn} (dB)
250	75
500	70
750	64
1000	62
2000	53

Alternative A

Referring again to Figures V-1 and V-2 and Table V-8, it is seen that some 105 and 37 people could be adversely impacted by diffuser aeration system noise at the Nutbush Creek and Sandy Creek plants, respectively. This analysis represents a worst-case condition because it considers direction of maximum noise radiation, absence of attenuation by physical barriers (such as trees) and no noise control treatment. But it does reveal that intruding noise could cause potentially serious adverse reaction from the approximately 20 inhabitants within 1,000 feet of both STP's and, therefore, implementation of noise control design features is indicated.

It is possible that some blasting will be required for construction along interceptor corridors and at the Nutbush Creek STP. Most animals in a high-noise area do not exhibit startle response to impulse or impact noise such as that associated with blasting; however, there are documented cases where blasting near water caused fish kills. These kills were not the direct effect of an acoustic pressure wave but more likely, a seismic pressure wave that is transmitted through the water. Death is caused primarily by rupture of fish air bladders. This is not expected to be a problem at the Nutbush Creek STP because there are no fish in the creek now near the plant site, nor will there be any during construction. Fish kills could occur if blasting occurs near the Sandy Creek water edge during construction of gravity interceptors at points of close approach to the creek.

As shown in Figure IV-1 of Chapter IV, the construction of new sewer mains includes the coupling of the new pump stations at the abandoned Red Bud Creek plant site to the Sandy Creek tributary system through Martin Creek. Figure II-18 of Chapter II indicates five residential areas will be in the path of these transfer facilities and may be adversely affected by construction noise, as described previously.

Alternative B

The assessment of noise and its impact discussed for the Sandy Creek STP of Alternative A is also applicable to the larger, single plant of Alternative B. About 37 people are likely to be adversely affected to some degree by operational noise, and about 19 persons may be seriously adversely affected by long-term noise and mildly annoyed by construction noise.

There are two additional major noise impacts associated with Alternative B. One is due to constructing the conveyance facilities linking the pumping station at the Red Bud Creek plant site to the Martin Creek interceptor, as described for Alternative A. The other results from constructing the force main through the populated areas of north, northeast, and east Henderson. Residents within two to four city blocks of the construction activity will be subjected to noise levels that are expected to cause annoyance. Any one household may be affected up to one month's duration.

Fish kills due to shock induced by blasting very near Sandy Creek for emplacing interceptors is also a possibility,

Alternative C

The assessment of noise and its impact discussed for the Nutbush Creek plant of Alternative A is also applicable to the larger, single plant of Alternative C. About 105 persons are likely to be adversely affected to some degree by operational noise, and about 18 persons may be seriously adversely affected by long-term noise and mildly annoyed by construction noise.

Emplacement of a force main and gravity interceptor across the northwest edge of Henderson and construction of a force main through north and east Henderson will constitute the primary construction impacts. The northeast force main will cause the greater impact because of the high density of population. Within two to four blocks of construction activity, local annoyance due to noise may be expected up to one-month duration.

As in the other alternatives, blasting of rock to emplace sewers along Sandy and Martin Creeks above the pump station has the potential for fish kills in those areas where blasting occurs very near the creek.

d. Geology

None of the system alternatives will produce or induce appreciable changes in the drainage patterns of the study area. Site preparation work at the Sandy Creek site will not be extensive, but it may divert surface drainage on part of the 50-acre tract to other points of entry along the Sandy Creek boundary of the tract. No adverse impact of such diversion is foreseen.

At virtually all creek crossings, but particularly those where sewer pipes are near the bottom of the stream bed, the pipe will be encased in concrete. This practice can ultimately produce local obstruction to flow due to erosion of the bed, and local changes in stream courses may be induced. In the study area, the concrete will be emplaced in very resistant mica gneiss, mica schist, or granite, and no streamflow obstructions are likely.

The Sandy Creek construction site for Alternatives A and B has at least fifteen feet of saprolitic material at the surface, according to the preliminary soils investigation by the design engineering firm. Excavation there is anticipated to be relatively easy, and blasting will not be required. At the Nutbush Creek site for Alternatives A and C, blasting will probably be required to excavate sites of several unit process facilities. Blasting will usually not be required for sewer pipe emplacement; however, rock may be shallow and sufficiently extensive to require blasting in certain locations. Perhaps five percent of the sewer length will be excavated by blasting at locations not now identifiable but dispersed over the various routes. It is anticipated that no borrow materials will be required other than those made available through on-site construction activity.

e. Soils

The Nutbush Creek site soils are significantly inferior to those at the Sandy Creek site with respect to erodibility. Moreover, because there is very little vegetative buffer available to impede runoff, the potential for siltation of the creeks in the immediate vicinity of the Nutbush treatment facility is rather high.

Soil loss may be quantified in terms of tons per acre per year, but the rate is dependent on many variables, several of which are not known with certainty. Soil erodibility factors for the soils at the sites are 0.43 for the Nutbush site and 0.24-0.32 for the Sandy Creek site; these are linearly related to the gross erosion that would occur, other factors being equal, on the soils exposed with construction and are directly comparable. Soil management factors in the watershed, also linearly related to gross erosion, are more severely affected by the Nutbush Creek facility than the Sandy Creek facility, owing to the relatively small basin size. Higher sediment delivery ratios (i.e., that percentage of gross erosion which may be measured as sediment yield in a stream) result from the small drainage basin size (DO-069). Construction at the Nutbush Creek site in Alternatives A and C may be expected to cause larger than "average" problems with respect to erosion and stream siltation. Such problems demand special mitigative measures, discussed in Section VI.B.1.e.

Dried sludge material for all alternative plants will be initially disposed of at the existing sanitary landfill (See Figure V-10) a few thousand feet north-northwest of the Nutbush Creek plant site. This is current practice and no problems are known to occur from this activity. The dried sludge is generally compatible with other municipal refuse and will comprise less than one percent of the current daily input. This very small percentage increase in input represents the incremental impact to the soils that are severely disturbed and eroded at the present site. The disturbance and eventual compaction of the soils drastically reduces their stability, tilth, productivity, and suitability for virtually any other use.

f. Water

In this subsection, water-related impacts are organized by impacts on streamflow and impacts on water quality.

(1) Streamflow

The flow regimes of creeks receiving wastewater discharge will be variously altered upon implementation of the alternatives. The alterations include increases in stream discharge during low flow periods; under normal flow conditions, diurnal fluctuations in discharges due to treated wastewater inflows will be undiscernible.

Increases in streamflow associated with wastewater discharges generate several impacts, some of which are specific to the various alternatives. A slight amount of additional erosion and siltation may occur locally as the receiving stream adjusts to its new hydrographic equilibrium condition. Generally, however, the increased low and average flows will not be manifested as substantially increased velocities, but rather as increased cross-sectional areas and as sufficient energy gradient to accommodate the flow. Hydraulic changes are not generally capable of effecting significantly greater erosion (i.e., scour), in that the stream channel is naturally "pre-adjusted" for its stage-velocity relation as influenced by the stability of banks and bottom. (Erosion may be extensive if bankfull stage is exceeded and channel enlargement is initiated; the increase in flows due to wastewater discharge relative to flood flows corresponding to bankfull (or greater) stage is negligible.)

A small amount of sediment due to the increased discharge may be transported downstream as suspended or bed load. This sediment will tend to settle out in the downstream reaches where hydraulic gradients are lower. Some sediment may be ultimately trapped in larger impoundments downstream.

All alternatives require decommissioning the existing Red Bud Creek plant, now discharging to Ruin Creek; in addition, Alternative B would involve decommissioning of the existing Nutbush Creek plant as well. Such decommissioning will remove the wastewater discharge from the receiving streams. Because under existing conditions most low flow in these creeks is treated effluent, the subsequent reduction in flow below the outfall location could result in virtually zero low flows in these small creeks during dry weather, particularly as urbanization of the watershed progresses (see below). No one is known to utilize these creeks for domestic purposes now, and similarly no plans for such use in the future are known. The outfalls of the treatment plants are in rather remote areas; even at the design population, very few people will inhabit areas nearby these streams below the outfall location. As currently occurs in the upper, more developed parts of the basins, the streams below the outfall locations will also likely promote vector (insects that transmit disease) or other nuisance insect activity during dry summer months after decommissioning (i.e., with very low flow or stagnant water conditions). Abundant places above the outfall locations currently exist in dry weather for insects to breed and live, and it seems unlikely that additional insects will be noticed in these populated areas as a direct result of lower flows much farther downstream after decommissioning. However, an increase in absolute number of insects in the study area is probable, even though the perceived concentration may remain unchanged from existing conditions.

Indirect secondary effects of the project on water quantities are related principally to the impact of increased urbanization on streamflow, which accrues from all alternatives. As a result of increased impervious area and higher flow velocities from storm sewerage, flood peaks will increase and lag times (time from centroid of rainfall to centroid of runoff) will decrease, resulting in flashy runoff events. A greater percentage of rainfall will discharge as runoff and, therefore, ground-water recharge will decrease; this decrease in recharge is usually manifested as decreased base flow to streams caused by lower potentiometric levels. Lower low flows will exacerbate surface water quality problems by reduction in assimilative capacity. While flooding is of only local (if any) concern in these headwaters, increases in peak flows that accompany urbanization will also tend to enlarge existing channels through erosion and decrease bank stability. Thus, another secondary impact is a likely long-term increase in suspended solids and turbidity from sediment in area streams. As mentioned in the previous section, Nutbush Creek Basin is characterized by more erodible soils than other parts of the study area.

Alternative A

The design flow for the Nutbush Creek plant of Alternative A, 1.58 MGD (2.45 cfs), is essentially equal to the present treatment plant discharge rate of about 1.6 MGD (2.48 cfs). Under design waste flow conditions, the new Sandy Creek plant will increase the 7-day, 10-year low flow from 2.3 cfs to 5.6 cfs, an increase of 156%. The additional wastewater represents only an 11% increase in average streamflow. The contribution of the wastewater to flood flows, i.e., storm runoff, is negligible.

At the present time about 3 MGD (4.6 cfs) of water from Sandy Creek is used as Henderson's municipal supply upstream of the proposed discharge. Upon its discontinuation of service in September, 1976, the average flows of Sandy Creek will also be increased by this amount from this source. The low flows given above for Sandy Creek will not be affected by the discontinuation of this water supply in that the low flows were calculated on the basis of no upstream usage. This incremental flow is not causally related to the proposed wastewater facilities but usually will provide additional dilution water and "assimilation capacity" that previously were not available and generally will reduce the effects of wastewater discharge on streamflow.

Because Laurel Mill, some 11 miles below the outfall, is a National Register site, special consideration was given to assessing possible water-related impacts on its environs. A minor amount of sediment derived from increased streamflows ultimately may be trapped in the mill pond and, thereby, decrement its useful life. However, most of the siltation that occurs in Laurel Mill pond in terms of mass is related to flood flows which extensively scour and degrade the channel upstream of the pond. Hydraulic calculations indicate that the additional flow in Sandy Creek will not prevent drawdown of the mill pond at Laurel Mill for periodic maintenance, nor will it impose a disadvantageous time delay. Even at augmented average flow conditions, the water level in the pond may be lowered to the dam crest within one hour. At flows under which dam maintenance would be performed, the drawdown time will be somewhat less.

Alternative B

The 7-day, 10-year low flow of Sandy Creek will be augmented from 2.3 cfs to 8.0 cfs, an increase of 248%, and average streamflows will be increased by 18%. Comments pertaining to Sandy Creek and Laurel Mill in the discussion of Alternative A are also applicable to Alternative B, although slightly more siltation for the larger discharge may be expected. In particular, even the larger discharge of Alternative B will impose no constraint on maintenance at Laurel Mill pond.

Alternative B has a beneficial impact in that it protects Nutbush Creek from primary impacts which otherwise may exist.

Alternative C

The low flows of Nutbush Creek are practically zero, so the 3.70 MGD (5.72 cfs) discharge would result in virtually 100% treated effluent as the stream low flow; while the discharge would be more than double that of existing conditions, the present discharge also results in a highly effluent-dominated stream. The combination of higher discharge and erodible soil may be expected to increase stream siltation both in Nutbush Creek and at its confluence with Kerr Reservoir. The increased discharge to Nutbush Creek will have a negligible effect on the residence (detention) time of water in the Nutbush arm of Kerr Reservoir.

(2) Water Quality

(a) General

Water quality of streams affected by the wastewater treatment system, particularly streams receiving treated wastewater, deserves detailed examination. The streams in the area are small, and perturbations may cause large impacts on water quality including siltation, dissolved oxygen depression, increased nutrients, bacteriological aspects, and indirect impacts related to urbanization.

Siltation

Erosion of the treatment plant construction sites and possibly in areas where sewer line construction approaches or crosses streams will degrade water quality with suspended sediment, increase stream turbidity, and, thereby, detrimentally affect aquatic biota and stream aesthetics. Suspended sediment can introduce to the stream a variety of pollutants, especially agricultural chemicals, which may represent a more long-term hazard to water quality if extensive erosion takes place. As shown in Sections V.B.1.e. and f., the Nutbush Creek site has the potential for both high erosion mass rates and large impacts on water quality due to sediment delivery to the stream from eroded areas. It seems likely that even with some erosion and sediment control measures, the water quality of Nutbush Creek will ultimately reflect this high erosion potential.

The ultimate depositional area of uncontrolled, eroded sediment from Nutbush watershed will be the uppermost part of Nutbush arm of Kerr Reservoir. The sediment will eventually shoal there and, in conjunction with increased nutrients, may promote growth of rooted aquatic vegetation in the area. Such growth will likely cause aesthetic degradation in the upper portion of the reservoir, particularly after scouring with flood flows or in response to fluctuating lake levels. Less siltation from construction activity in Sandy Creek basin may be expected; any eroded sediment will probably be trapped for an indefinite time in downstream impoundments.

Dissolved Oxygen

The wastewater effluents will depress the dissolved oxygen (D.O.) content of each of the receiving streams downstream from the outfall. The degree of this D.O. "sag" and its extent over the length of the stream depend on waste volume and oxidation rate and stream reaeration rate. These factors can be modeled under certain assumptions which are reviewed in the Technical Reference Document (RA-R-276). The model is patterned after a well-known general utility formulation of the DO-BOD coupled system (TH-067). Parameters are based on hydrologic observations and measurements made in the various basins and on behavioral characteristics of typical municipal wastewaters. Results of exercising the D.O. model for receiving streams under 7-day, 10-year low flow conditions, design wastewater flows, and requisite effluent quality (from waste loads allocated by DNER-DEM) are shown as profiles in Figures V-6 and V-7 and as spot values of D.O. on an area map in Figure V-8. These results and their significance are summarized for the specific alternatives in separate subsections following the general discussion in this subsection.

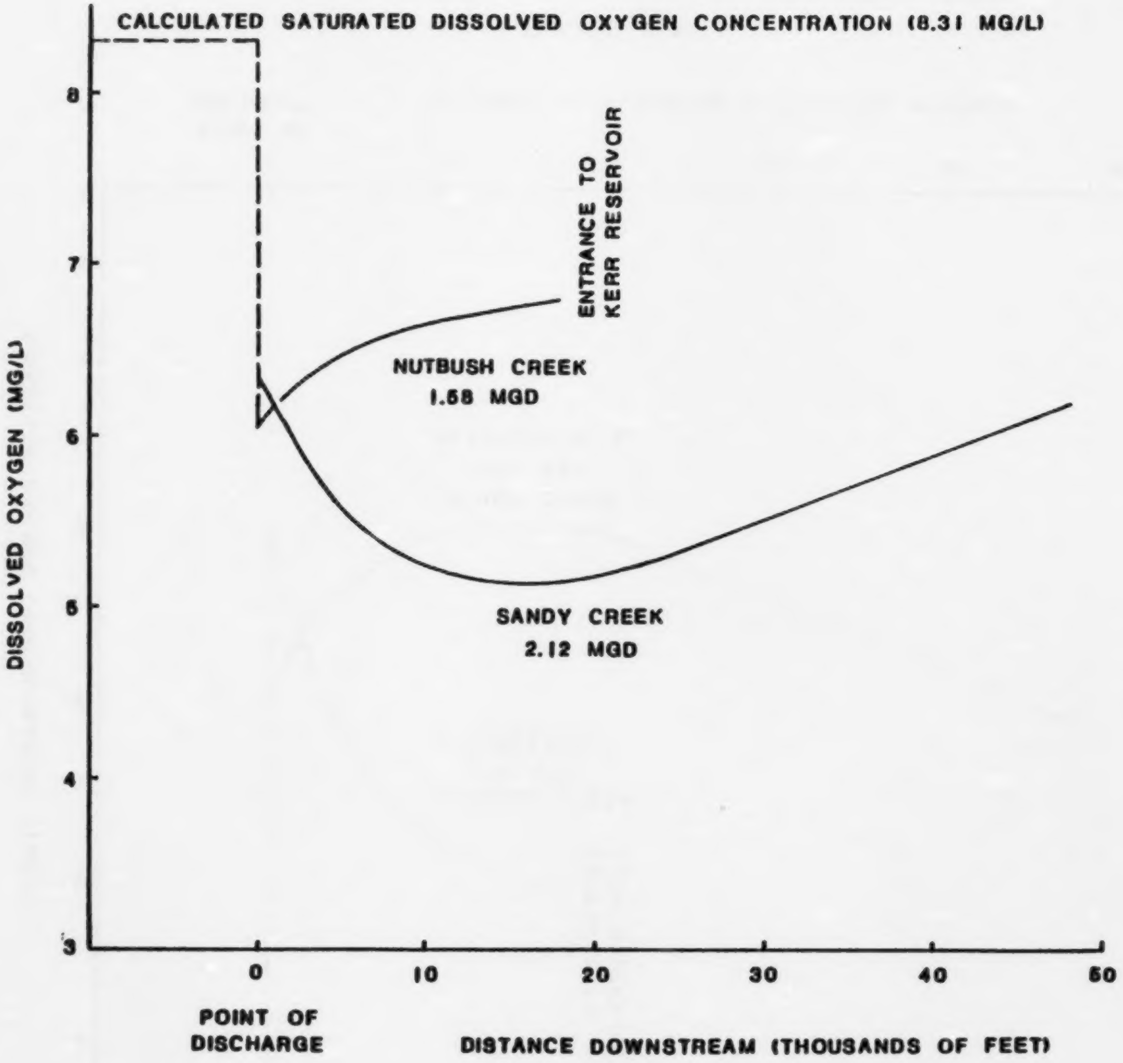


FIGURE V-6
CHANGE IN DISSOLVED OXYGEN CONCENTRATION WITH
DISTANCE DOWNSTREAM FROM POINT OF EFFLUENT DISCHARGE

ALTERNATIVE A

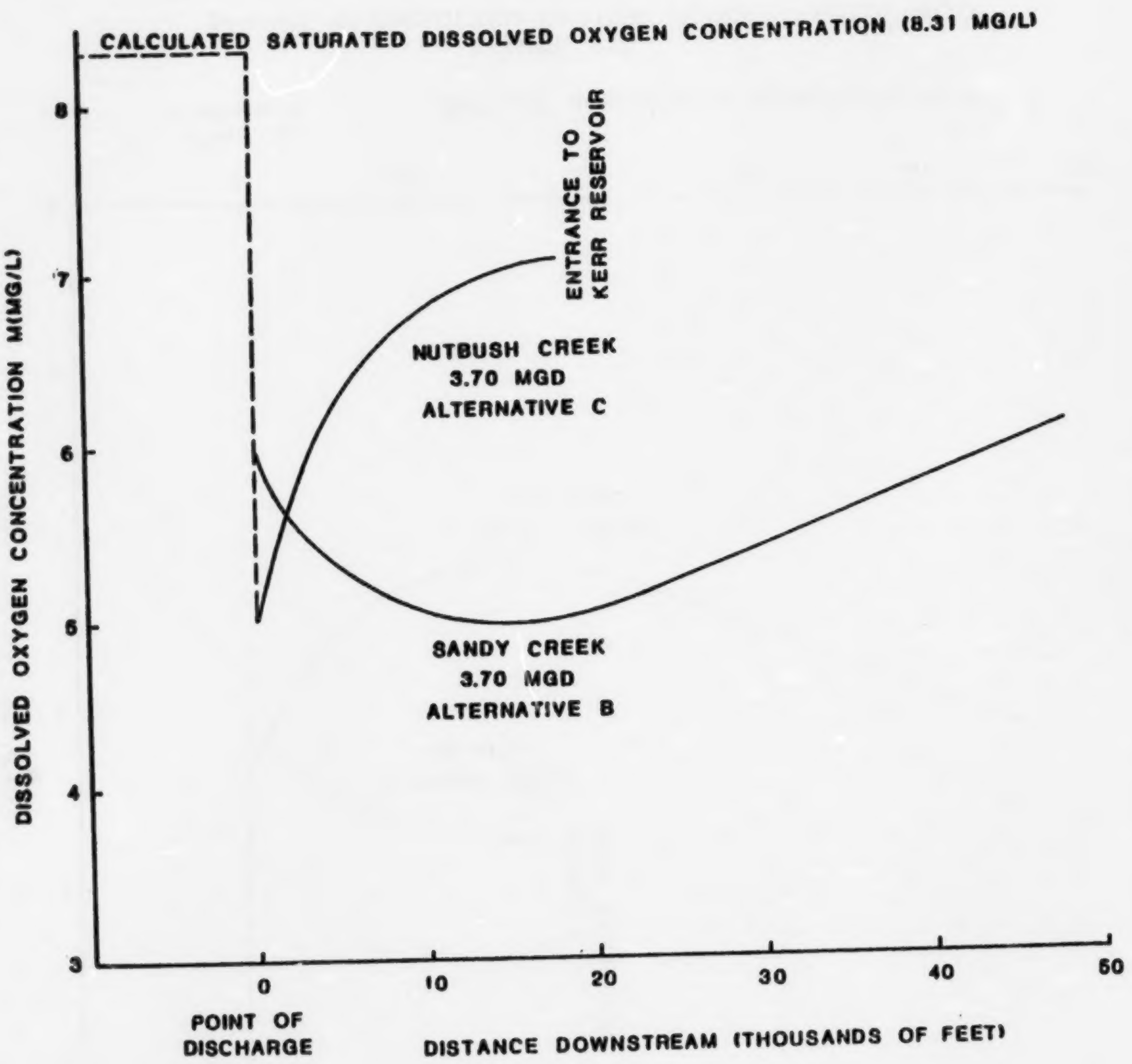
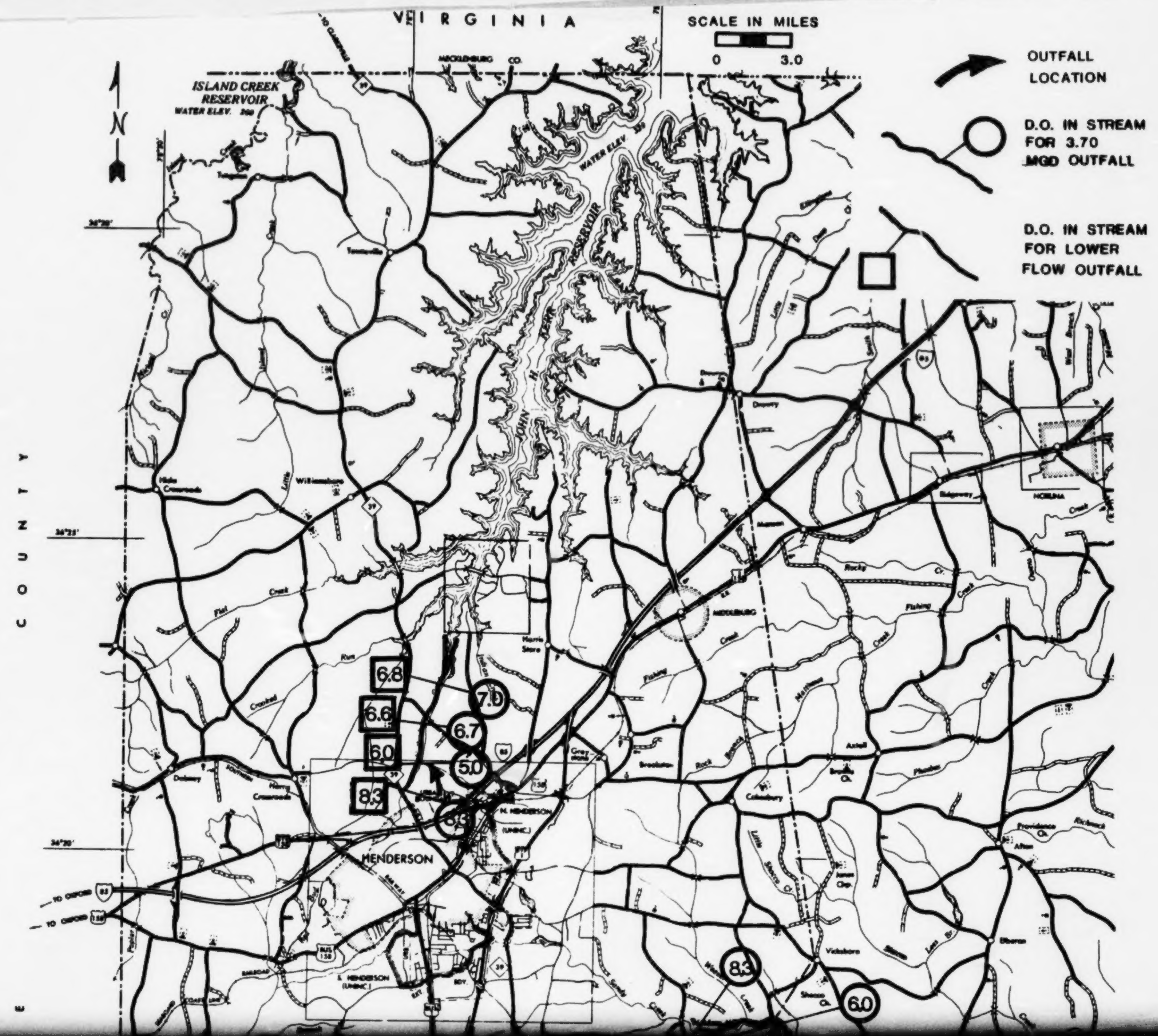
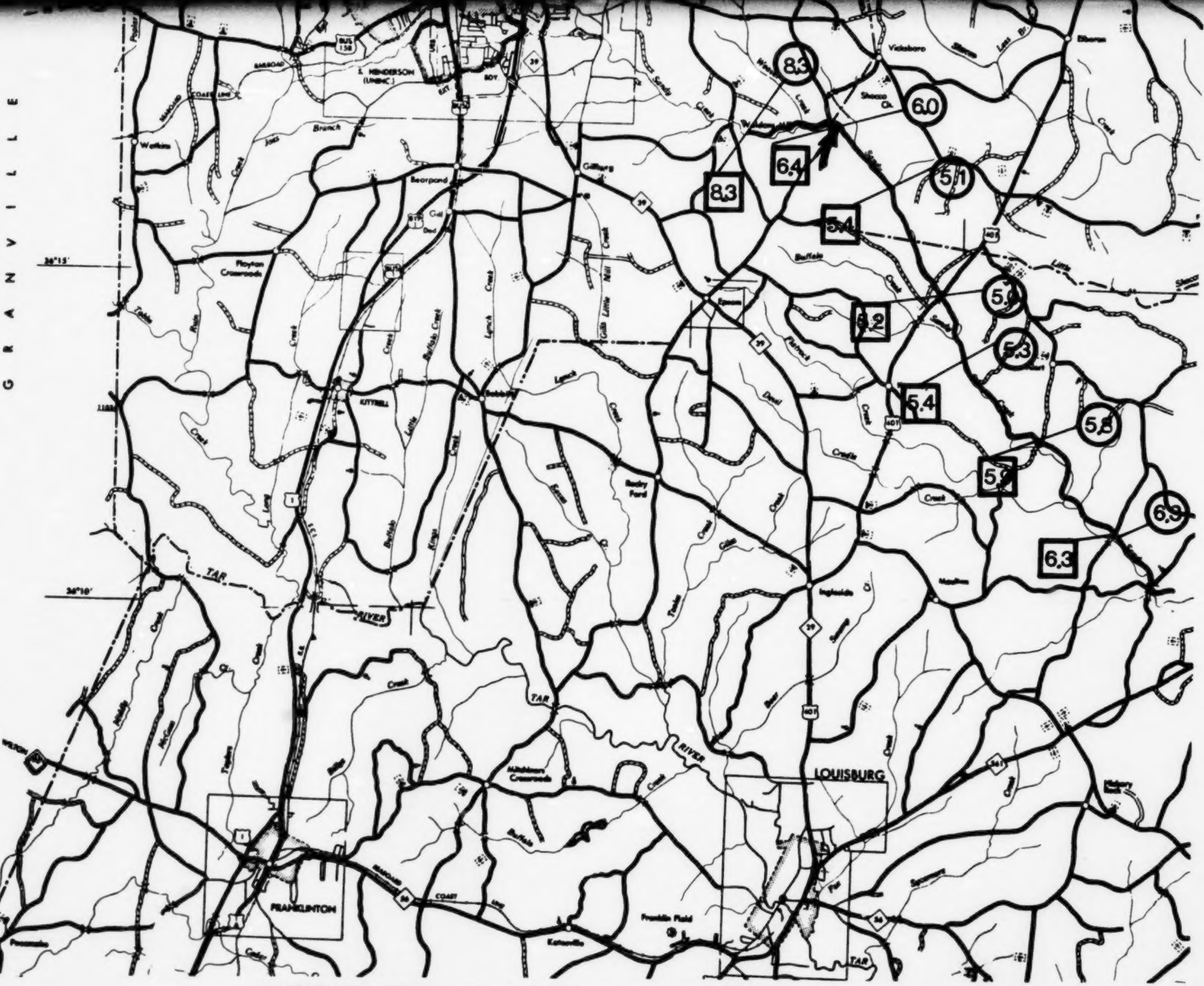


FIGURE V-7

CHANGE IN DISSOLVED OXYGEN CONCENTRATION WITH DISTANCE FROM EFFLUENT DISCHARGE


VIRGINIA
SCALE IN MILES
0
3.0
OUTFALL LOCATION
D.O. IN STREAM FOR 3.70 MGD OUTFALL
D.O. IN STREAM FOR LOWER FLOW OUTFALL
N
ISLAND CREEK RESERVOIR
WATER ELEV. 260
MECKLENBURG CO.
JOHN H. KERR RESERVOIR
WATER ELEV.
COUNTY
MIDDLEBURG
NORLINA
Ridgeway
Drewry
Manson
Townsville
Hicks Crossroads
Williamsboro
Harris Store
Gray Rock
Brookston
Kittrell
Dabney
Harris Crossroads
Cokesbury
Axtell
Afton
Vicksboro
Epsom
Flat Creek
Rocky Cr.
Fishing Creek
Little Shocco Cr.
Shocco Cr.
Sandy Creek
HENDERSON
N. HENDERSON (UNINC.)
S. HENDERSON (UNINC.)
TO OXFORD
85
158
39
1
7.0
6.7
5.0
6.8
6.6
6.0
8.3
8.3
6.0
36°20'
36°25'
36°30'


GRANVILLE
S. HENDERSON (UNINC.)
Vicksboro
Bearpond
Gillburg
Epsom
Kittrell
Bobbitt
Royster Ford
Ingleside
Franklin Field
Plaxton Crossroads
Mitchiners Crossroads
Kearney
LOUISBURG
FRANKLINTON
TAR RIVER
Buffalo Creek
Lynch Creek
Cedar Creek
Shocco Cr.
8.3
6.0
6.4
8.3
5.1
5.4
5.3
5.4
5.8
6.3
36°15'
36°10'

DISSOLVED OXYGEN CONTENT OF STREAMS BELOW PROPOSED OUTFALLS

FIGURE V-8

Nutrients

Nutrient removal will not be accomplished in any of the alternative systems as evaluated in this section, and the discharges will add substantial quantities of nutrients to the streams. Nitrogen will be in a readily available nitrified form, chiefly nitrate. Phosphorus will be in several forms but generally as organically-bound phosphorus and orthophosphates. The approximate increments to in-stream concentrations of nutrients in the vicinity of the outfalls for the various alternatives are discussed below under appropriate subheadings. Generally, the increased nutrient levels will provide favorable conditions for algal and other aquatic growth downstream from the outfalls. Aquatic algal growth is inhibited when nitrogen or phosphorus concentrations are below 0.2 or 0.05 mg/ℓ, respectively; optimum nutrient concentrations for algal growth are 1.0 to 7.0 mg/ℓ nitrogen and 0.1 to 2.0 mg/ℓ phosphorus (TH-069) and optimal N/P ratios are about 15:1 (FR-187).

If a water body becomes over-enriched in nutrients that are the limiting restraints on aquatic plant growth, the water body is considered "eutrophic;" a eutrophic condition is often accompanied, particularly during the warmer season, by depletion of dissolved oxygen from excessive utilization by aquatic biota. For this reason algal blooms, for instance, indicate a period of high stress on other aquatic biota and may be accompanied by widespread fish kills through asphyxiation. If a water body is nutrient-deficient, then excessive algal or other plant growth can not occur, and dissolved oxygen resources are generally not diminished to critical levels; this more healthy condition defines an oligotrophic water body. A mesotrophic body of water is in an intermediate condition with respect to nutrients and biologic activity.

Nutrient enrichment and ultimate eutrophicaion of Kerr Reservoir 17,000 feet downstream of the Nutbush Creek plant outfall is of special concern in evaluating both primary and secondary impacts. To estimate the potential for eutrophication of Kerr Reservoir, it was assumed that no nutrients were removed by aquatic growth in Nutbush Creek, i.e., both the effluent from the STP on Nutbush Creek and urban runoff were assumed to directly enter the lake. The Larsen-Mercier (LA-230) and Vollenweider (DI-109) evaluation concepts were then applied to two successive reaches (from backwater to FAS 1308 bridge to near the regional water treatment plant) to infer the potential for eutrophication by phosphorus loads in upper Ker Reservoir. The Larsen-Mercier technique appears to have more validity in this application and, therefore, is used to illustrate the potential for eutrophication. The fact that the Larsen-Mercier model provides a better "fit" to observed water quality conditions than the Vollenweider model suggests the high retention coefficients (related to the lake sediments' assimilation capacity for P) may be particularly important in controlling the trophic condition. The analysis using the model is based on nutrient budgets given by Weiss and Moore (WE-222).

Figure V-9 indicates the modeled relationship between the upstream and downstream reaches for existing conditions for several configurations of the proposed Nutbush Creek STP and for typical urban drainage from Henderson in the year 1999. Also shown for purposes of comparison is the loading resulting from the STP with phosphorus removal; this is discussed further in Section VI.B.1.f. as mitigative measures. The lines segregating the plot space into eutrophic, mesotrophic, and oligotrophic conditions are based on approximate, empirical relations and correspond to constant average phosphorus concentrations in the lake water of 10 μg/ℓ and 20 μg/ℓ. The utility of these plots is predicated on the assumption that phosphorus is or will be limiting

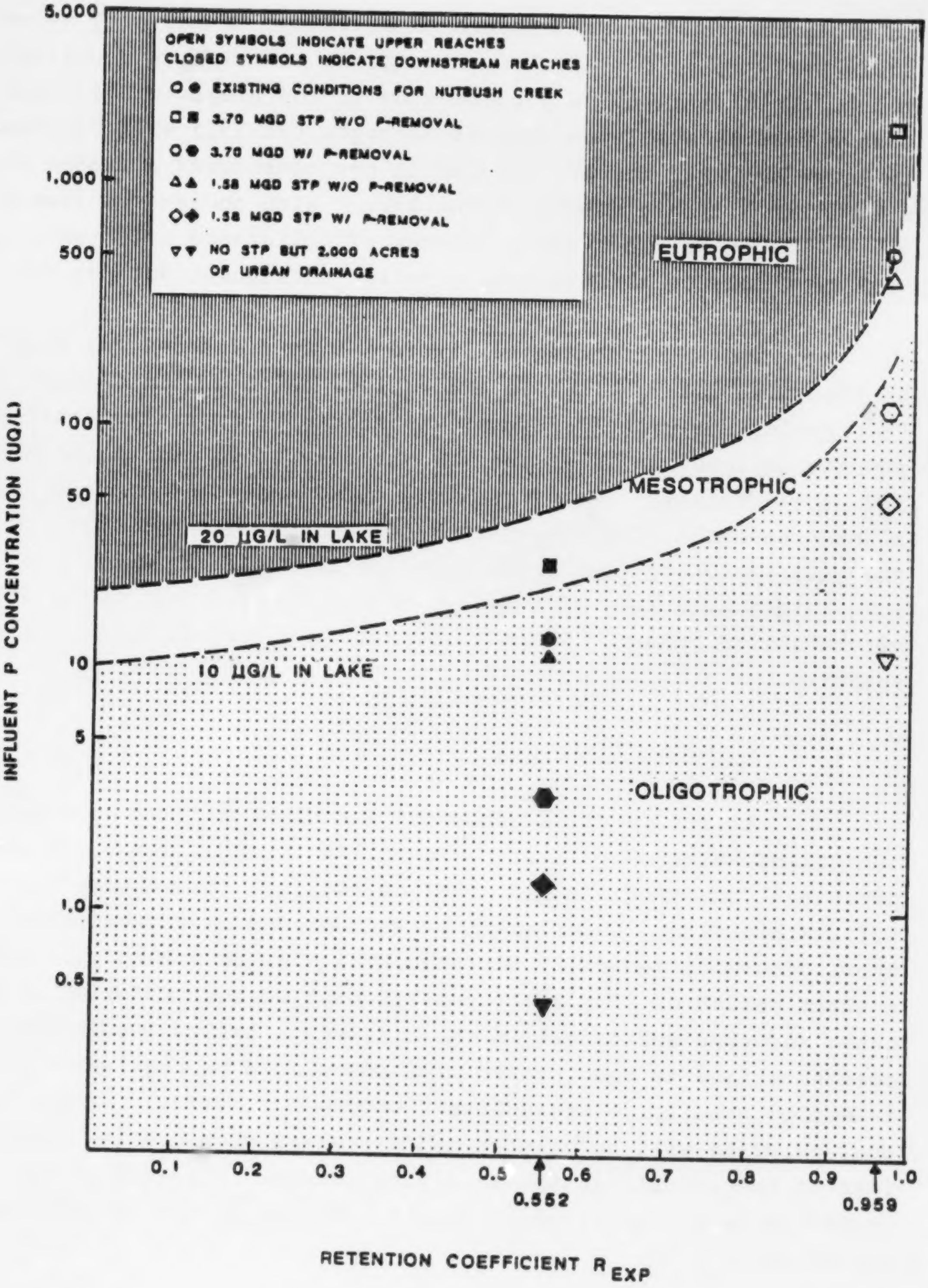


FIGURE V-9
LARSEN - MERCIER MODEL OF KERR RESERVOIR

to biologic growth. Even though this assumption may only be unequivocally valid for existing conditions in the more downstream reach, the nitrification process step of the proposed STP assures that a readily available form of nitrogen (WE-233) will be present in large amounts; hence, nitrogen is not considered a factor that will limit biologic growth in the lake. With phosphorus removal at the STP or with non-point sources of pollutants only, phosphorus will certainly be the limiting nutrient throughout Nutbush arm.

The significance of Figure V-9 is discussed for each of the three alternatives in subsections below and in Chapter VI, "Mitigating Measures." However, it should be emphasized that the phosphorus loadings in Figure V-9 are only those due to the STP and urban drainage. Nutrients from other non-point sources, including one-half of the current nitrogen load and one-third of the existing phosphorus load, will continue also to enter the lake in unpredictably increasing amounts, regardless of the alternative system chosen. Trophic impacts from various sources are additive.

Chlorine Residuals

Efficient disinfection of municipal wastewater requires sufficient chlorine to meet the complete chlorine demand plus an additional quantity, termed chlorine residual, to provide bacterial disinfection. Under commonly encountered operating practices, where economics generally dictate, HOCl will be present for only a short period of time after contact with organic material and other reducing substances in the effluent. Residual chlorine concentrations in the treated effluent should be negligible. Disinfection usually is accomplished before the outfall. Any residual chlorine will be diluted and disappear within a few tens of feet of the outfall in the receiving stream. Chlorine is not expected to be a significant ecological burden on any of the receiving streams.

Fecal Coliform

The wastewater treatment plants and other components in all alternatives are to be designated Class I reliability systems. This rating assures that design features, operational procedures, and materials will be provided to offer a high degree of protection against major plant malfunctions. Nevertheless, remote pumping station bypassing, treatment plant malfunctions, or operator error could result in discharge of untreated or very poorly treated sewage. Such discharges are possible and have occurred in similar plants in the past. All alternatives have a pump station on Sandy and Red Bud Creeks, and all suffer from the possibility of degrading the City of Henderson's supplementary water supply.

The ability to accommodate the water quality effects of upset conditions, particularly dissolved oxygen depletion and bacterial contamination, is variable among the alternatives. While D.O. depletion would probably cause fish kills and malodorous conditions for miles downstream of outfalls in any of the alternatives, the ecological damage would likely be temporary. Consequently, bacterial contamination and the public health hazard thereby engendered is considered more important and has been investigated in more detail. A total coliform count of 1,000/100 mℓ is the criterion for public health maintenance in water-contact recreation (CL-039); this is not the water quality standard because clearly non-standard conditions are under consideration. The exponential decrease in total coliform bacteria in raw sewage due to dilution and die-off has been modeled for low stream (plug) flow and a simple first-order removal assumption (i.e., conformance to Chick's Law). Coliform die-off data collected from intensive studies on the Tar River at Rocky Mount were used in the model. The objective of this modeling was to define the areas in which the public health hazard under upset conditions might exist, and these areas are delineated in the subsection discussing the water quality aspects of the specific alternatives.

Sludge Disposal

A poorly situated or operated sanitary landfill can degrade both surface-water and ground-water quality. The Vance County Landfill No. 2, while not ideal in its physical setting, is apparently not now a significant threat to either water regime. The incremental impact of additional sludge disposal is not expected to alter this situation. The erosion of the unvegetated soil used for cover material probably contributes to suspended and bed-load sediment concentrations that are higher than otherwise, but degradation of surface waters by poor-quality leachate has not been documented. The nearest surface stream and the stream most likely to be affected in the future by any poor-quality discharge from this landfill is the unnamed tributary to Crooked Run just west of the landfill. (See Figure V-10). This stream is not monitored for water quality currently, but no complaints on its quality have been recorded by the Granville-Vance Health District offices.

Degradation of ground water by landfill leachate is more subtle, more difficult to detect, and more difficult to control than degradation of surface streams. While landfilling is an accepted practice for sludge disposal, the emplacement of refuse, including sludge, near the bedrock-soil interface at the Vance County landfill increases the likelihood of and the velocity of downward percolation of any leachate to the saturated zone through bedrock fractures. However, the ground-water flow paths in the saturated zone from this landfill site on the upland surface tend to be long and permit more effective attenuation of any deleterious constituents in the leachate. The dried sludge material is compatible with and probably no more toxic than most of the other

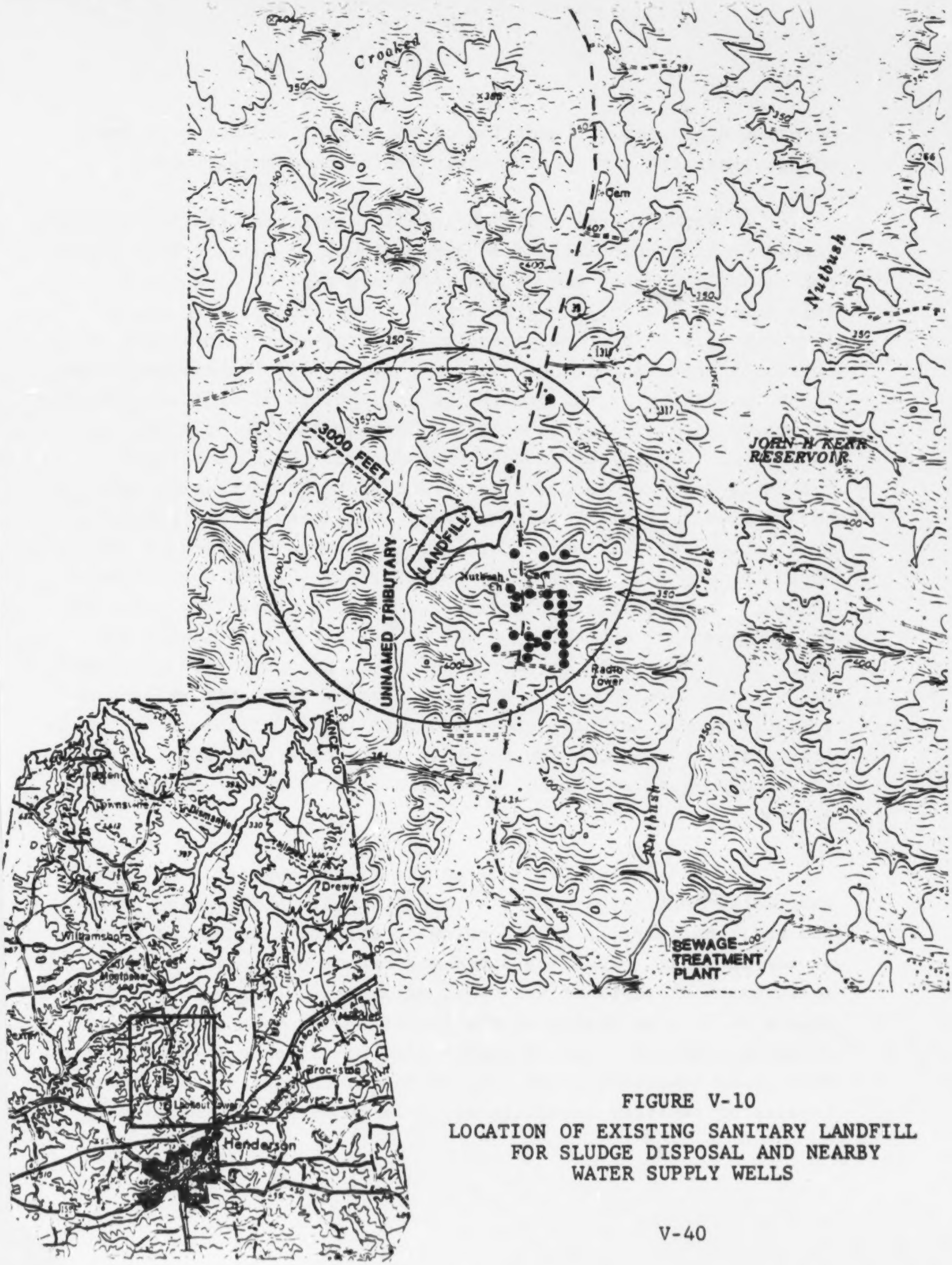

Crooked
Nutbush
Cem
JOHN H KERR RESERVOIR
3000 FEET
LANDFILL
UNNAMED TRIBUTARY
Nutbush Ch
Cem
Radio Tower
Creek
SEWAGE TREATMENT PLANT
VANCE CO
Drewry
Williamsboro
Creek
Henderson

FIGURE V-10

LOCATION OF EXISTING SANITARY LANDFILL FOR SLUDGE DISPOSAL AND NEARBY WATER SUPPLY WELLS material deposited in landfills of this type, and its very small volume generates a proportionately small incremental impact.

Water in contact with landfill material, whether contaminated or not, eventually discharges slowly to both Nutbush Creek and probably Crooked Run as base flow and perhaps directly to Kerr Reservoir as well. Figure V-10 shows the relation of the landfill site to surface waters and to proximal ground-water wells currently used as private water supplies. All of these wells are close to Highway 39 and are the water supplies of individual houses or groups of four or less houses. They are all in bedrock, usually cased through the unconsolidated regolith (which ranges in thickness from ten to forty feet) and range in depth from about one hundred to several hundred feet. Water levels are generally several tens of feet below the land surface. In this area the water is very hard, a typical characteristic of the metavolcanic sequence in which the wells are located. Those wells closest to and northeast or northwest of the landfill are most likely to first experience any contamination of ground water from the landfill, if it should occur. The fact that no wells appear contaminated now does not preclude the possibility of future water quality problems, owing to the relative youth of the landfill and the slow ground-water movement, even in a fractured bedrock aquifer system.

Very little (if any) of the sludge generated by the new wastewater facilities of any alternative will be disposed of at the existing landfill tract, owing to the short remaining life of the landfill. The likelihood and extent of the impacts of solid waste disposal of all types of material in the future will depend to a large degree on the specific site selected which is currently unknown. (An adjacent tract is possible.) Nevertheless, with sound engineering and site selection principles, the adverse impacts of sanitary landfills are able to be all but eliminated and the incremental impacts of disposing increased amounts of sludge can be negligible. Vance County should continue actively to locate, investigate, and construct a new suitable landfill in a timely manner to mitigate such impacts.

Secondary Impacts

All of the proposed actions will also directly affect water quality by encouraging urban growth. Drainage from urban areas typically is of poor quality with substantial amounts of dissolved solids, oxygen-demanding material, suspended solids, oil and grease, pathogens, nutrients, and toxic substances. Generally, non-point source pollutant loadings to streams may be compared on an areal basis, and the projected increased pollutant loads are approximately directly proportional to the increase in area of the various basins. These projected increases in pollutant loads due to increased urbanization are 44, 239, and 182 percent for Nutbush Creek, Sandy Creek, and Red Bud Creek basins, respectively. The resulting increases in concentrations of the various constituents are not proportional to increase in basin area because the amount of runoff also increases with urbanization and because the basins are of different sizes. The highest concentrations of pollutants in urban drainage will occur in the smallest basin during the early stages of a storm event.

The Larsen-Mercier model indicates that urban runoff per se is no threat to eutrophication of Kerr Reservoir, even with maximum development at the end of the design period. On the other hand, all of the project alternatives will provide sewerage service to thousands of persons who otherwise would be using septic tanks. The potential degradation in ground-water quality and the nutrient (especially nitrogen) contributions to surface waters which take place through septic tank use are thereby avoided. Therefore, provision of sewer service includes a substantial beneficial impact.

(b) Water Quality Impacts by Alternatives

Impacts on water quality for each of the three alternative systems are summarized and discussed in this subsection.

Alternative A

The D.O. sag in Sandy Creek occurs about 15,000 feet downstream of the outfall and has a minimum value of 5.1 mg/ℓ. There is virtually no sag in Nutbush Creek due to very efficient reaeration from the relatively high stream slope and velocity; the minimum occurs at the outfall and is about 6.0 mg/ℓ. No adverse effects attributable to D.O. levels are foreseen for either stream even under extreme low-flow conditions.

It should be noted parenthetically that the small pickle plant discharge of 0.1 MGD upstream from the Nutbush Creek STP outfall will have an almost negligible influence on D.O. at the STP outfall after the pickle plant achieves its compliance schedule in 1977. Owing to the very high stream gradients in the uppermost Nutbush Creek basin, the reaeration coefficient is so high that the stream will completely assimilate the rather small waste load of the pickle plant and no depletion in the dissolved oxygen resources in the stream immediately above the Nutbush Creek STP will result. The pickle plant discharge, therefore, is beneficial in that it provides additional dilution water at the STP outfall, although the resulting increase in D.O. of Nutbush Creek is of very minor significance. The effects of the pickle plant discharge, consequently, were not considered in the D.O. modeling.

The treated wastewater effluent to Nutbush Creek will beneficiate the existing water quality and induce a gradual recovery from its existing anoxic condition. After several scouring episodes from flood events have removed most of the benthal oxygen demand, Nutbush Creek should return to a water quality condition that is typical of small streams in urbanized areas; its subsequent health will depend more on effects of urbanization than on the new STP discharge. This is also true for Sandy Creek, but to a lesser extent, in that it is a considerably larger stream.

The increase in concentrations of nutrients below the outfalls for the two receiving streams is given in Table V-9.

TABLE V-9

CONCENTRATION OF NITROGEN & PHOSPHORUS FOR TWO STREAM FLOW CONDITIONS ON NUTBUSH & SANDY CREEKS

	7/10 Low Flow		Average Stream Flow	
	Nitrogen (mg/l)	Phosphorus (mg/l)	Nitrogen (mg/l)	Phosphorus (mg/l)
Nutbush Creek	28.6	9.8	9.7	3.3
Sandy Creek	17.1	5.9	2.8	1.0

The nitrogen/phosphorus ratios are about 3:1. Comparison with threshold nutrient concentrations given in the preceding subsection's general discussion and the existence of rather high biologic productivity in Sandy Creek (and, by inference, the rejuvenated Nutbush Creek) suggest that these additional nutrients will be readily utilized. This probable increase in productivity will be apparent in the form of excess algal (especially unicellular) growth and aquatic weedy growth. The extent of stream over which algal growth will occur depends on factors such as "luxury" uptake, changes in depth of photic zone, and the detention effect of ponds. It seems probable, however, that several tens of miles of Sandy Creek, and all of Nutbush Creek, will be affected to some degree. Water detention areas, such as larger pools and ponds, will be adversely affected. The magnitude of the increased productivity at any one point and subsequent impacts, if any, are unknown.

Making the conservative assumption that the nutrient reduction from the outfall to the entry to Kerr Reservoir is very small, the Larsen-Mercier model indicates that the discharge itself will result in mesotrophic conditions in the portion of Nutbush arm above the 1308 bridge, and oligotrophic conditions will exist below this bridge. When viewing the combined influences, however, the continuation of discharge of existing phosphorus loads from the Nutbush Creek STP point source of Alternative A will serve to maintain the overall eutrophic existing condition in the upper reach which may eventually manifest itself as poorer quality water. The conversion of nitrogen forms to the more available nitrate in the nitrification step at the STP also may be important to water quality degradation if part of the uppermost area is nitrogen-limited, as is believed. It is concluded that Alternative A, without phosphorus removal, will contribute significantly to long-term deterioration of water quality in this upper reach, even though no water quality impacts related directly to the wastewater discharge *per se* should accrue. No buffer is provided for water quality degradation due to ongoing suburban and recreational lakeshore development. Control of pollutants from such development is considerably more costly, less effective, and more difficult to implement than appropriate controls at large point sources.

The known water-contact recreational areas downstream of both outfalls have been evaluated for susceptibility to public health hazards if system upset were to occur. The probability that this will occur is extremely small, but the potential direct effect on quality of the human environment requires its consideration. Upset conditions in which sewage is only routed through the plant, receiving only incidental treatment and no chlorination, are emphasized as worst-case conditions.

For such an upset at the Nutbush Creek STP, a public health hazard throughout the length of Nutbush Creek would exist. Even though coliforms concentrations rapidly decrease with the small advection in the lake, the hazardous area could extend into Kerr Reservoir for two to three thousand feet, to a point about midway in the finger of Nutbush Creek in the uppermost Nutbush arm above the 1308 causeway. These areas are classed "C" waters and are, therefore, not intended for water-contact recreation. Such recreation is known to occur, especially in the summer months, in the affected reservoir area (JA-144). It is also possible that the proposed upgrading of usual water quality in Nutbush Creek will induce a small amount of water-contact recreation there at some time in the future.

For the Sandy Creek STP of Alternative A, a larger stream segment, about 25 miles, will be temporarily affected owing to the more rapid advection in the stream compared to that of the lake. The known water-contact recreational areas on Sandy Creek and the change in stream classification from "C" to "B" begin about 10 miles downstream of the Sandy Creek STP outfall, although, as with the future Nutbush Creek, some minor water-contact activities may take place now above this point in the "C"-classified segment.

Alternative B

The D.O. sag in Sandy Creek occurs about 14,000 feet downstream of the outfall and has a value of 5.0 mg/ℓ which is the lower limit of the applicable water quality criterion for dissolved oxygen. The nutrients added to Sandy Creek by the STP appear to be of larger concern with respect to water quality. For nitrogen, the initial concentrations of effluent-derived nutrients for low and average streamflows are 20.7 and 4.5 mg/ℓ, respectively; for phosphorus, they are 7.1 and 1.6 mg/ℓ, respectively. As with Alternative A, it seems likely that the increased productivity will result in an indeterminant amount of algal growth. The comments made under Alternative A with respect to the effect of nutrients on streams are particularly applicable in view of Sandy Creek's high productivity and the relatively large discharge proposed. Some algal blooms and growth of rooted aquatics in the larger ponds downstream are not unexpected.

An important water-qualty aspect specific to Alternative B is the removal of the discharge to Nutbush Creek and Kerr Reservoir. This feature obviates the potential problems concerning eutrophication and future water quality degradation of the lake and will promote recovery of Nutbush Creek itself to a condition dictated principally by urban runoff quality. The probability of a public health hazard to Kerr Reservoir, however, may in fact be slightly increased due to the substitution of a pumping station for the treatment plant at the Nutbush Creek STP site; pump-station bypassing of raw sewage is generally recognized as more probable than treatment plant malfunctions, although bypassing usually occurs only in limited amounts and during high streamflow periods which mitigate its effects.

The possibility of system upset for Alternative B is higher than the other Alternatives owing to the number of pumping stations. For the treatment plant itself, however, the probability of plant malfunction that results in a public health hazard is equal to the other STP's, i.e., very small. If such an upset were to occur, about 26 miles of stream would be temporarily adversely affected from a public health standpoint, about the same as that for Sandy Creek in Alternative A.

Alternative C

There will be no D.O. sag in Nutbush Creek below the outfall for this alternative; the initial value of 5.0 mg/ℓ, achieved through stipulating the waste D.O. content as 5 mg/ℓ, increases by downstream reaeration so that the stream contains about 7 mg/ℓ at its entry to Kerr Reservoir. For this alternative, as with Alternative B, nutrient loadings are of greatest concern with respect to water quality impacts, chiefly because of Kerr Reservoir's proximity and to a lesser degree, due to the rejuvenated Nutbush Creek. For nitrogen, the initial concentrations of effluent-derived nutrients for low and average streamflows are 28.8 and 15.6 mg/ℓ, respectively; for phosphorus, they are 9.9 and 5.4 mg/ℓ, respectively. These relatively high concentrations of nutrients and the return of Nutbush Creek to an aerobic condition strongly suggest that appreciable algal growth in Nutbush Creek may result from the proposed discharge. The comments made under Alternative A with respect to the effect of nutrients on streams are particularly applicable in view of the high initial concentrations and loadings of nutrients. In any event, because the Nutbush Creek outfall is only three miles above Kerr Reservoir, it seems likely that only a small portion of the nutrient loadings will be consumed before entry to the lake.

Larsen-Mercier theory strongly suggests that Alternative C, without phosphorus removal, will increase and hasten the existing trend toward eutrophy in the upper reach above the 1308 bridge. Below this bridge, the STP of Alternative C *per se* will promote mesotrophic conditions, which permits very little addition from other nutrient sources without jeopardizing water quality. This is especially significant in view of the regional water supply and treatment plant at the lowermost end of the portion of the lake under consideration. Alternative C, without phosphorus removal, must be considered a long-term potential threat to the effectiveness of the regional water system and almost certainly will cause algal blooms, excessive aquatic plant growth, and possibly nuisance conditions eventually in the upper reach above the 1308 bridge.

An important water quality aspect specific to Alternative C is the maintenance of Sandy Creek, a relative large, highly productive stream in a substantially unstressed state. This feature obviates potential water quality problems related to excessive nutrients and STP malfunctions. Moreover, this benefit is achieved without the penalty of a pumping station that would not otherwise exist because all alternatives contain one pumping station near the confluence of Sandy and Martin Creeks. Thus, the system reliability of Alternative C is probably higher than the other two alternatives, one of which has one more STP, and the other of which has one more pumping station. This fact may be translated to a smaller probability of severe water quality degradation induced by upset conditions. However, if the STP on Nutbush Creek of Alternative C did malfunction, then the temporary public health hazard would be essentially the same as that for upset of the Nutbush Creek STP of Alternative A; the hazardous area would include all of Nutbush Creek downstream from the outfall and up to several thousand feet into Kerr Reservoir. This hazardous area would be entirely within the existing Class "C" waters.

g. Land/Water Interface

The increased siltation of streams from erosion at construction sites and increased streamflow may cause local hydrographic changes, particularly at the confluence of Nutbush Creek and Kerr Reservoir for Alternatives A and C. As noted previously, slight increases in stream stage will occur on Sandy Creek for Alternatives A and B and on Nutbush Creek for Alternatives A and C. These are likely to be of little significance *per se*.

More extensive and intensive urbanization of the watersheds in the study area will be promoted by any of the alternative systems. As explained in Section V.B.1.f.(1), increased urbanization is generally accompanied by higher flood peaks. Higher flood peaks inundate more area, particularly at those locations where the floodplain is relatively wide, such as at the confluence of creeks. The only existing development in Nutbush Creek Basin that appears susceptible to increased flood damage from urbanization is the Nutbush Creek STP, especially if it is upgraded and/or expanded. A flood protection berm may be required to prevent damage at some time in the future. The increased upstream flooding caused by such a berm is probably negligibly small for a high-gradient stream such as Nutbush Creek. Future land development should recognize the increased flood hazard that accrues with progressive urbanization of a watershed.

h. Sensitive Areas

The impacts on sensitive areas affected by the alternatives have already been characterized. There are two areas sensitive to physical/chemical disruption. The erodible soils of the Wilkes association at the Nutbush Creek site in Alternatives A and C were described in Section V.B.1.e. Second, the apparently fragile relationship between water quality in Kerr Reservoir and the lake's trophic state is greatly perturbed by wastewater discharges to Nutbush Creek in Alternatives A and especially C as described in Section V.B.1.f.

2. Biological Components

a. General

All three alternative systems will have the beneficial effect of removing the effluent presently being discharged into

Red Bud Creek by diverting it to one of the other treatment facilities and either improving or removing the effluent to Nutbush Creek, thereby upgrading the overall water quality of these creeks in the area. Any of the systems will provide adequate facilities to handle the projected wastes from the Henderson area through the year 1999. Each will, therefore, cause the same amount of secondary impacts by promoting additional growth in the area. Concomitant degradation of the natural environment through construction, urban runoff, air pollution, and general disturbance that occurs when people gather in large numbers will occur through growth mainly in the vicinity of the present city limits of Henderson. The majority of the future secondary construction will occur in the upland pine-hardwood forests with little occurring in the floodplains (as seen on the maps in Chapter II.B.). The construction noise and destruction of habitat will affect the populations of animals in the study area. These changes will be small when viewed on a regional basis since the amount of existing habitat is quite large and the amount of anticipated urbanization is small and occurs mostly in already urbanized areas. The additional storm water runoff from the urbanized areas will add in quantity to the flood peaks of the streams. This in itself will not have a significant effect on the biota of the area. The increase in water contaminants in the street runoff will add to the existing pollutant loads and tend to degrade the water quality of the creeks. The increase in the amount of these contaminants due to the increased urbanization will contribute to the larger stress placed on aquatic biota in these streams and impair their ability to function in their ecological niche.

The construction of the pipelines along Martin and Sandy Creeks, a common component of all alternatives, will cause perhaps the most significant change in the terrestrial flora. It will destroy for the duration of the use of the facilities a strip of river-edge hardwood forest about 50 feet in width along and, in some cases, crossing the creeks. This will take these areas out of forest production because of the practice of keeping the easements cleared of all but low vegetative cover. It will, however, provide diversity in the habitat along the streams that will encourage more diverse animal and plant communities. Along the edges of the disturbed area, where more sunlight penetrates to the forest floor, dense growths of honeysuckle, blackberries, and various briars and vines will occur in addition to grasses in the mowed segment. This will provide cover and food for many species of animals not presently found in large numbers in those areas, such as rabbits, quail, rodents, and field birds. The initial disturbance from construction will not have a lasting effect on the animals. Those disturbed during the spring and summer breeding or nesting seasons will suffer the most adverse effects; however, that will only be for one season. The construction will proceed in a linear fashion so that the disturbance by equipment will not be felt along the entire route at once. Larger animals, such as deer, turkey, hawks, and owls will leave during construction and return after it is completed.

Since all of the forests observed along the routes have been logged previously, there are no "unique" woodlands to be avoided. There may be some rocky (gneiss) outcrops that may contain some unique species of mosses that should be avoided; however, these (if there are any) can be located during the surveying of the pipeline easements. None were found during the site visits.

b. Land

Alternative A

The construction of Alternative A will have several impacts on the terrestrial flora and fauna. It will destroy between 24 and 28 acres of forest at the plant and pump station sites and an additional 62 acres of river-edge hardwoods along the pipeline routes (assuming a 50-foot easement). The pipelines would extend for about 10.2 miles along the creek banks or floodplains. This is about 8% of the total length of creeks in the study area. Since the construction of the plants and pump station would occur at discrete locations as opposed to the pipelines, the disturbance to the area biota would be minimal. The noise, dust, and general disturbance of these areas would not cause a significant change in the biota of the study area. The small acreage involved, less than 30 acres in three discrete areas, will not change the overall plant and animal populations of the study area to a measurable degree. After construction, the plant and pump station areas will become feeding grounds for many small birds and mammals, especially rabbits, gophers, and moles, due to the short grass inside the fenced areas. Most larger animals will become accustomed to the facilities and will venture up to the fenced boundary. The increased "edge" habitat will support larger populations of birds and small mammals, and their predators.

Alternative B

The terrestrial effects of Alternative B will be similar to those of Alternative A since the facility sites are the same and the pipelines follow the same routes in the creeks. The amount of land used for construction of facilities (pump stations and treatment plant) will be between 29 and 33 acres. A total of 12.2 miles of pipelines will be routed through or near creek beds and their floodplains. This will destroy about 74 acres of river-edge hardwood vegetation (50-foot easement). This also represents about 9% of the total creek length of the study area.

As with Alternative A, the long-term adverse impacts of Alternative B on the terrestrial biota are not large enough to be discerned on a local or regional basis. The increase in "edge" habitat in Alternative B will increase the populations of rabbits and other small mammals and birds that use the food and cover provided by brushy edges. The predators (foxes, owls, hawks) that prey on these small animals will also be found more frequently in these areas after construction. No long-term adverse effects on terrestrial biota are anticipated from Alternative B.

Alternative C

Alternative C will have a slightly different effect on the terrestrial biota of the study area. Since all units will either be gravity-sewered or pumped through force mains to the Nutbush Creek facility, which will be expanded from 1.84 to 3.70 MGD capacity, additional pipelines will be needed in areas not affected by Alternatives A or B. A total of about 13.7 miles of pipelines will be put through stream valleys. This will severely disturb a total of about 83 acres if each requires a 50-foot easement. If the Sandy Creek gravity and force mains share an easement, the effect will be lessened by about 3.8 miles of easement. About 10.5% of the linear creek bed in the study area will be affected. Also an additional 13 to 17 acres will be necessary for the pump station (1 to 5) and expansion of the existing Nutbush Creek facility (about 12). The long-term effects on the biota of putting the force main in the Red Bud Creek drainage would be minimal since it will follow the existing easement and then be ~~routed~~ through urbanized areas for most of the rest of the way. If the return force main along Sandy Creek follows the gravity collector easement and is constructed at the same time, there will be no additional terrestrial habitat impacts over those caused by the construction of the gravity sewer. This would essentially lower the total terrestrial area affected by Alternative C to a total of about 80 acres.

The long-term terrestrial effects of Alternative C will be similar in nature to those of Alternatives A and B. They differ only in amount and location of habitat destroyed. Alternative C will affect essentially the same habitats as A and B with the addition of some minor changes in the Red Bud Creek area due to the new force main and the deletion of 17,000 feet of force main along Sandy Creek.

c. Water

Alternative A

The operation of Alternative A will have some beneficial and some possible adverse impacts. The beneficial impacts derive from improving the quality of the effluent from the Nutbush Creek facility and the concomitant increased stability lent to its aquatic ecosystem. The upgraded treatment will remove most of the suspended solids presently entering the ecosystem and the oxygen-demanding materials will be restricted to acceptable levels. Because the natural flows of Nutbush Creek are low, the addition of the effluent significantly increases stream discharge; this increase is beneficial to biota, as long as nutrient concentrations are not excessive, and this benefit will be maintained in this alternative. The amount of nutrient inputs from the STP will remain approximately the same as with existing conditions. Nutrients presently introduced to the Nutbush Creek ecosystem are apparently assimilated in the food chain of the lower reach of the reservoir in such a manner to avert excessive algal growth and associated problems of low dissolved oxygen. However, the assimilative capacity in the upper reach is probably now being exceeded in the summer months.

The transformation of various nitrogen forms to the more available nitrate form may increase the biologic productivity somewhat (over what would otherwise exist), especially in the uppermost portion of the lake. As can be seen in the previous section on water quality impacts, the upper reaches of the Nutbush arm of Kerr Reservoir border on being eutrophic according to the Larsen-Mercier criteria. This indicates that, biologically, the upper reaches of the reservoir are virtually as productive as possible without the occurrence of algal blooms and excessive growth of filamentous algae and rooted aquatic vegetation. In fact, very recently, algal blooms and an associated fish kill have been reported in the upper reach. Alternative A, in conjunction with existing and future nutrient sources, could contribute to a long-term trend toward further eutrophication; it will not improve the existing condition with respect to eutrophication, and additional algal blooms and fish kills can be expected.

The operation of the new Sandy Creek facility will discharge an average 2.12 million gallons of treated effluent daily (at maximum capacity) in the now relatively undisturbed and highly productive creek. This discharge has the potential for causing several adverse effects.

The Environmental Protection Agency and the state require the effluent to contain no more than 17 mg/ℓ of BOD-5 and 6 mg/ℓ of ammonia-nitrogen as a long-term average. The suspended solids content of the effluent will also be very low under proper operating conditions; however, the BOD will cause a sag in the dissolved oxygen levels downstream from the discharge. Computer modeling indicates that D.O. levels will reach a low of about 5.0 mg/ℓ for 4,000 feet between 14,000 and 18,000 feet downstream under the worst credible conditions at 2.12 MGD discharge. This is equivalent to the minimum allowable average of 5 mg/ℓ set by the State of North Carolina for this type of stream and is considered high enough to prevent adverse impacts on aquatic biota. Downstream, the D.O. rises again through reaeration; about 48,000 feet from the discharge, D.O. should be restored to near normal levels. The increased flow in the creek will not adversely affect the aquatic organisms since they quickly adapt to the variations in water level of about the same magnitude that occur naturally. There is a potential, however, for one possible significant adverse biological effect. Increased nutrient loading (primarily of nitrogen and phosphorus) could cause localized nuisance growths of unicellular green and blue-green algae and filamentous green algae during the warm summer months. This may occur in ponds such as Laurel Mill, where the stream velocity decreases and shallow areas are present. An increase in rooted aquatic vegetation, such as cattails, parrot feather, and other shallow-water growths, may also occur, particularly in areas relatively close to the outfall. Due to the reaeration potential of the flowing stream, it is unlikely that these growths would lower the D.O. sufficiently to cause problems. The major adverse impacts of excess growth would be aesthetic; large die-offs could also cause odors, although this possibility is not considered great.

Alternative B

The discharge of sewage effluent to Sandy Creek in Alternative B will be increased by 1.58 MGD over the design capacity of Alternative A, thereby making a total discharge of 3.70 MGD. The qualitative aspects of anticipated water quality impacts change only slightly, with a BOD-5 of 15 mg/ℓ and ammonia-nitrogen of 4 mg/ℓ permissible. However, due to the increased amount of effluent, the total loading will still be increased.

All of the effects stated in the previous section concerning the Sandy Creek STP of Alternative A will be magnified for Alternative B. The lowest calculated D.O. levels will still be 5.0 mg/ℓ but will occur at about 10,000 feet below the discharge and extend (at 5.0 mg/ℓ) to about 20,000 feet downstream under the worst credible case. D.O. again will rise to about ambient levels by 50,000 feet downstream due to reaeration. This in itself should have no ill effects on the aquatic biota. The increased nutrient loading will still have a significant potential for causing growth of aquatic vegetation. Impacts of such growth, beyond those on the aesthetic appeal of the creek, should not arise unless growths are so heavy as to cause nighttime D.O. reductions due to plant respiration. This effect would occur only in slow-moving pools or ponds, if at all.

Alternative B will have the beneficial effect on Nutbush Creek of removing the discharge of sewage effluent. All wastes will be pumped from the present Nutbush Creek facility to the proposed Sandy Creek facility. This will allow Nutbush Creek to return to a more natural condition. It will decrease the flow of the creek below the facility by 1.84 MGD and decrease the nutrient loadings to the Nutbush Creek areas of Kerr Reservoir. This will return the upper portions of the reservoir to a stable, oligotrophic level, according to the Larsen-Mercier graph. There may be a noticeable decrease in productivity of the upper portion of the lake that may result in a very slight lowering in fish production. This impact would be difficult to detect, however.

Alternative C

There is a large difference between the effects of Alternative C and the other two alternatives with respect to impacts on the water-oriented biota of the area. Under Alternative C there will not be discharge into Sandy Creek. All effluents will be discharged into Nutbush Creek. The discharge will be 1.86 MGD more than present capacity, making a total of 3.70 MGD; however, the suspended solids content of the effluent will be greatly lowered by the upgraded treatment process. As in Alternative A, the effluent will contain nutrients in the form of nitrogen, phosphorus, and other substances of minor importance. This increase in flow, together with a decrease in suspended solids, should be beneficial to the portions of Nutbush Creek between the facility and Kerr Reservoir. The addition of more nitrogen in the readily usable nitrate form, as well as more phosphorus, however, has the potential for causing excess algal growth in the upper reaches of both Nutbush Creek and the Nutbush arm of Kerr Reservoir. Impacts of increased nutrient input to Nutbush Creek itself will be similar to those expected from discharge into Sandy Creek under Alternative B. Dissolved oxygen will fall to a low of 5 mg/ℓ immediately below the discharge point and will recover to nearly 6 mg/ℓ at the entrance to Kerr Reservoir. These levels are depressed but not sufficiently low to result in adverse impacts on the aquatic community in and of themselves. Increased nutrient loading, however, might cause some localized algal growth, creating an aesthetic nuisance in pools or slow-flowing segments.

The addition of large amounts of nitrogen and phosphorus into the creek and the upper reach of the Nutbush arm will increase primary productivity. Whether the discharge will cause excess algal growth that will become a biological problem in the lake is uncertain, according to Dr. Charles Weiss (WE-233), an expert on the water quality of the reservoir. Recent algal blooms and fish kills in the upper reach indicate that the probability is high that such impacts would accrue. The discharge places the upper portions of the reservoir well into the eutrophic zone, according to the Larsen-Mercier theory, which predicts excess growths of filamentous and attached algae, plankton blooms, and excess growth of rooted aquatic plants. Due to the extreme fluctuations and high turbidity (low light penetration) of this portion of Kerr Reservoir, it is unlikely that attached filamentous algae or rooted aquatic plants would become established along the shore. Blooms of unicellular or filamentous mat-forming algae would probably continue and increase in area affected.

d. Land/Water Interface

Alternatives A and B

Because of their similar pipeline route alignments, Alternatives A and B will have essentially the same effect on the land/water interface. The only adverse impacts will arise from construction disturbance in the terrestrial environment and from temporary siltation and turbidity caused by pipeline construction at creek crossings. Pipeline rights of way will not be routed in creek beds, and the impacts of construction will be confined to stream crossings. The pipelines associated with Alternatives A and B have essentially the same routes and are similarly aligned with respect to the creek beds. The gravity sewer to the Sandy Creek plant extends further up Sandy Creek in Alternative B, between Highways 39 and U.S. 12. The additional impact of this increase in length, however, is expected to be minor. Since the State of North Carolina requires strict measures to guard against erosion of creek banks and siltation of creeks from construction runoff, the effects of Alternatives A and B on the land/water interface should be very minor.

Alternative C

Alternative C uses the same pipeline alignments along Martin and Sandy Creeks as Alternatives A and B, except for the force main carrying effluent from the Sandy Creek pump station. This main will not necessarily follow Sandy Creek. If it does, it is assumed that it will be routed along the same easement as the gravity main. The pressure main in Red Bud Creek will cause additional disturbance of the land/water interface where it crosses the creek. Application of the State of North Carolina's regulations will, as in the other two alternatives, protect the creek from excessive impacts during construction.

e. Sensitive Biological Areas

No truly sensitive areas were found along any of the pipeline routes near the treatment facility locations or in the discharge areas. The biota of the entire area has been disturbed by man in one way or another for the last 200 years or more. Logging, agriculture, human habitation, and road-building have at some time affected the entire area. Some areas are in the later stages of succession, with a vegetation and associated fauna near the ultimate climax type; however, due to the constant presence of man, the system will never be what it was prior to man's intervention. There are several areas of rock outcrops and river-edge hardwood forests in the later stages of succession that are quite scenic; however, these are neither unique nor superior to habitats in similar areas that occur over a large portion of the North Carolina Piedmont region. There are also rare species of mosses (previously named) that occur on large rock outcrops in the Henderson area; however, none were found along the proposed Alternatives' routes. Therefore, since there are no known endangered plants or animals in the path of the system, no areas can be called biologically sensitive.

C. Man-Made Environment

1. Demography

The construction and operation of the proposed sewage treatment facility will have a very small impact on the population of Vance County, of Henderson, or of any localized area. Direct impacts on the population are brought about by the numbers of people added to the population by the work force required during construction and operation of the facility. In the case of the proposed sewage treatment facility, approximately 30-40 workers will be employed during construction. Of these, 20-25 will be skilled and the rest unskilled laborers drawn from the local labor force. Some of the skilled jobs can be filled from local labor. The total number of workers brought into the area will probably be 25 to 30 and the total population will increase by 75 to 100 people. Due to the short period of construction, this population increase will be a short-term increase. The addition of no more than 100 people to Vance County and to Henderson will have a very small impact. This number represents approximately 0.3% increase in the county's population and 0.7% increase in the population of Henderson. Such increases can very adequately be accommodated by the social and municipal systems of the area.

Long-term population increases are brought about by the labor force that migrates to the area for the operation of the sewage treatment facility. The proposed project will require an operation force of 10-15 workers. Of these, several can probably be hired from the local labor force. At most, no more than 40-50 people will move to the area as a direct result of the proposed facility. This number represents an increase of less than 0.2% in Vance County and less than 0.4% in Henderson. These increases can be accommodated by the existing social and municipal services with little or no expansion of existing facilities.

Indirect impacts of the proposed facilities on area population can conceivably be more pronounced than direct impacts. Expansion and upgrading of the wastewater treatment system includes the accommodation for industrial growth. Should new industries locate within the area, potential economic growth would be much larger than increases directly related to the wastewater treatment system. Other secondary effects will be the stimulation of service industries associated with the new industries and, consequently, creation of additional jobs, most likely for the unemployed in the local labor force.

2. Economy

Construction of the wastewater treatment facility will require the importation of some 30-40 construction workers and their families. Consequently, there will be a small increase in retail and wholesale sales directly attributable to the project. Secondary impacts will result from construction and operation of new industries that may locate in the area after installation of the proposed system. Types and sizes of these industries, if any, are not known at this time (1976). No significant differences among the three alternatives are evident with respect to the magnitude or type of economic impacts.

The total construction cost for Alternative A is approximately \$7.049 million and the total annual operation and maintenance cost is approximately \$388,600. Of the total operation and maintenance costs, slightly less than \$100,000 will be paid annually for salaries. The incremental increase over the present salaries paid is small and essentially no economic impact should result on the city.

The total construction cost for Alternative B is approximately \$9.076 million and the total annual operation and maintenance cost is approximately \$324,200. Of the total operation and maintenance costs, approximately $80,000 will be paid annually as salaries. The incremental increase over the present salaries paid is small and essentially no economic impact should result.

The total construction cost for Alternative C is approximately $6.291 million and the total annual operation and maintenance cost is approximately $281,000. of the total operation and maintenance cost, approximately $80,000 will be paid annually as salaries. This incremental increase over the present salaries paid is small and essentially no economic impact should result.

The people to be most economically affected by the proposed project are the landowners with property selected for new plant construction and those with land in the vicinity. The property owners with land or right-of-way to be used for the proposed facility could possibly make a profit from the sale of land. No large gains would be expected to the landowners affected, however. The owners of property near the plant site could expect a short-term decrease in property value as a result of the wastewater treatment facility. This land would not be favorable for residential use, but re-zoning could make it suitable for new industrial growth. If new industry is brought into the area, the values of property near the plant could also increase.

3. Economic Geography

a. Land Use

In Chapter II, sensitive natural areas were broadly identified and displayed in Figure II-16. A review of the interceptor routes and wastewater treatment plant locations in Chapter IV reveals that each of the three candidate alternatives poses essentially no substantial threat to these areas, given the design constraints discussed elsewhere. For man-made sensitive areas, short-term inconvenience of visitors to historical sites will occur equally for the three alternatives during periods of interceptor construction near these sites. Because Laurel Mill is the subject of expressed sensitivity, it is treated separately in the next subsection.

A review of Figures V-1 and V-2 reveals the following population distribution as a function of distance from each of the proposed wastewater treatment sites.

TABLE V-10

POPULATION DISTRIBUTION AROUND PROPOSED SEWAGE TREATMENT PLANT SITES

Distance From Plant Site in Feet	Population	
	Sandy Creek Site	Nutbush Creek Site
1,000	19	19
2,000	23	88
3,000	42	212
5,000	153	910

The large increase in the Nutbush Creek site at a distance of 5,000 feet results from the community location in north Henderson across Interstate Highway 85.

Construction of the facilities will cause some temporary disruption to nearby residences due to increased noise, traffic, and dust. The area of the STP's is expected to return to the same condition during operation as before construction, and no residences are expected to be relocated by construction or operation of any proposed facility.

Because the Nutbush Creek facility of Alternatives A and C represents only an expansion and upgrading of the existing plant, no essential change will result in land use at that site. The proposed site at Sandy Creek is currently used for agricultural purposes. Land use at this site will be converted from agricultural purposes to a wastewater treatment facility in Alternatives A and B.

Growth within the 201 facilities planning area has been projected to occur primarily within Sandy Creek and Red Bud Creek drainage basins (WO-086). Using these projections, the serviced drainage basin areas as shown in Table V-11:

TABLE V-11

PERCENT INCREASE IN DRAINAGE BASIN AREAS DUE TO POPULATION INCREASES

Drainage Basin	Existing Area (Acres)	Design Area (Acres)	Percentage Increase
Sandy Creek	825	2,800	320
Red Bud Creek	567	1,600	280
Nutbush Creek	1,385	2,000	140

Presently, neither the city nor the county has a master plan. The city has a zoning ordinance which has authority reaching to one and one-half miles in all directions from the corporate limits of the city, and the county has mobile home regulations.

Changes in existing land use will most likely occur in undeveloped areas adjacent to or nearby the built-up areas of the town. The location of major collector wastewater lines will, to a large extent, determine growth and development. Historically, major collectors were normally generated by the exigency of existing unsewered man-made environments or proposed new developments, such as residential developments, schools, commercial growth, and increased industrialization. The new collector lines will be approved by the City Council of Henderson, thus providing a unique opportunity to guide the growth of the area. The only existing constraints on the proposed system will be those of engineering feasibility.

b. Archaeological and Historical

(1) Archaeological

A complete and final assessment of the potential impact of proposed facilities on archaeological resources will be deferred until the selection of an alternative. At that time, locations that exhibit a high probability for containing archaeological resources and that will be affected by the selected alternative will be examined to determine whether or not significant archaeological resources will be endangered. If significant archaeological resources will be adversely affected by construction of the selected alternative, steps will be taken to mitigate impacts upon those resources.

Mitigation will consist of design alterations to avoid endangering the resources where this is feasible. Where this is not feasible, salvage excavations will be undertaken to retrieve scientific data contained in significant archaeological sites.

An archaeologist from the Archaeology Section of the North Carolina Department of Cultural Resources has examined two treatment plant locations proposed in the plan. No archaeological resources were identified at the Sandy Creek site, and no further archaeological work is recommended at that location. Some form of subsurface investigation, such as soil augering, is recommended at the Nutbush Creek site, if construction activities are to be carried out beyond the confines of the present plant site. If ground disturbance is limited to locations within the existing plant compound, no further archaeological work will be necessary at that location.

(2) Historical

Investigations of the potential impacts of each alternative on both National Register and state-designated historical, cultural, and architectural resources were performed. It was determined that Alternatives A and B will potentially affect Laurel Mill, a National Register site located approximately 11.1 miles downstream of the discharge of the Sandy Creek STP component. To better understand the impact of these alternatives on Laurel Mill, an analysis was performed to determine the effect of treated effluent discharged to Sandy Creek with regard to increased low flows, siltation of the mill pond, flooding and contamination of the owner's water supply spring, and aquatic growth in the mill pond.

Increased Low Flows: The concern here is that the increased flow in the stream due to the wastewater discharge will not allow the mill pond to be drawn down below the dam crest level with the existing gate so that periodic maintenance may be performed. (This concern is exacerbated by the flow augmentation which will result from the discontinuation of upstream Sandy Creek water as a municipal supply in July, 1976; this increased flow is causally unrelated to the proposed wastewater treatment project.)

Using standard, accepted design procedures, it was determined that, even with conservative parameters, the increased flow will not exceed the capacity of the gate, and will not appreciably increase the time required to draw down the pond. Results of the computations are tabulated as follows:

TABLE V-12

STREAM FLOW - DRAWDOWN TIME RELATIONSHIPS
FOR LAUREL MILL POND

Wastewater + Stream Flow (cfs)	Corresponding Head on Dam Crest	Corresponding Capacity of Submerged Gate	Time to Draw Pond Down to Crest
@ 7/10 Lo Flo=5.58	.075 ft	51.03 cfs	________
17.58	.162 ft	51.49	________
@ Avg. Flo = 35.58	.260 ft	53.44	56 min ± 5 min.

Because the time to draw down the pond even at a relatively high flow (compared to flows at which maintenance would be attempted) is not unreasonable nor especially disadvantageous, the time corresponding to lower flows was not calculated. In summary, the added flow to Sandy Creek beyond existing hydrologic conditions will not cause any additional burden to dam maintenance.

Siltation: There will, in all probability, be a very small increase in the amount of siltation within the pond at Laurel Mill. This increase derives from the increased flow, especially lower flows, in Sandy Creek downstream of the discharge with its accompanying increased "carrying capacity." However, the mass rate of sediment entering the pond during low flows is typically very small compared to that during flood flows, on which the discharge will have a negligible effect with regard to erosion or carrying capacity. Consequently, increased siltation due to continuous discharge is not likely to be a serious problem at Laurel Mill. There may be a short-term increase in suspended/settleable solids in waters of Sandy Creek until the stream returns to a hydrographic equilibrium under its new, altered flow regime. The magnitude of this increase is indeterminant but is believed to be quite small.

Flooding and Contamination of Water Supply Spring: The owner's water supply for his residence and mill is a spring in bedrock that is within the natural floodplain of Sandy Creek. While the spring and its open, unprotected storage tank have been flooded several times in the past, it requires a greater-than-average flood to reach the spring, owing to its relatively high location on the floodplain. The proposed treatment of the wastewater at the STP and the time of travel over the 11 miles from the STP to Laurel Mill (essentially an additional unit process) totally obviate a public health hazard. In addition, the very large dilution of the wastewater provided by the amount of the flood waters required to reach this spring (at least 1000 to 1) should assure the integrity of the drinking water supply, despite its periodic, naturally occurring inundation.

Aquatic Growth in Mill Pond: Another possibility for an adverse effect at Laurel Mill is stimulation of growth of algae and/or rooted aquatic plants in the pond due to the increased nutrients provided by the wastewater discharge. Generally, the 11+ miles separating the discharge point and the pond offer an opportunity for substantial nutrient removal, either by biological uptake or physical-chemical effects (settling out as precipitates, adsorption, denitrification, etc.). At the typical streamflows of Sandy Creek, aquatic growth stimulation to a point where nuisance conditions prevail is a possibility, especially for the 3.70 MGD discharge of Alternative B.

It is anticipated that Alternative B will also result in temporary construction disturbance in the area of Weldon's Mill, a state-designated historical resource. This disturbance will involve the presence of heavy construction equipment within 500 feet of the site and increased traffic during the construction of the force manin. Continuing construction traffic to an area sufficiently distant from the site will insure that no excavation damage occurs. Due to the temporary nature of this disturbance, it is not considered to have a significant adverse impact on this property.

A description of Alternative B and the above-listed potential effects on historical resources have been submitted to the State Historic Preservation Officer of North Carolina for his review and comments regarding the impact of this action on historical resources within the area. These comments will be incorporated into the Final Environmental Impact Statement.

Alternative C is not expected to affect either National Register sites or state-designated historical, cultural, and architectural resources within the project area.

c. Resource Use

Construction of Alternatives A, B, and C will require a permanent and irrevocable commitment of construction materials including cement, mineral aggregates, structural and reinforcing steel, pipes, valves, pumps, electrical equipment and wiring, and building construction materials. However, the major portion of construction materials will be purchased outside the planning area and local materials resource use for construction should be negligible.

Energy consumption for the operation of both the Nutbush Creek plant and the Sandy Creek plant of Alternative A will result chiefly from the use of the raw sewage lift station and the diffused aeration systems. Additional electrical energy will be required for operating the two new wastewater pumping stations at the Red Bud Creek plant site and at the confluence of Sandy Creek and Martin's Creek. However, these facilities are relatively small and the impact of this energy consumption on the planning area should be small if not negligible.

Energy consumption for the operation of the new Sandy Creek facility of Alternative B will result chiefly from the use of the raw sewage lift station and the diffused aeration system. Additional electrical energy will be required for operating the three new wastewater pumping stations at the Nutbush Creek plant site, the Red Bud Creek plant site, and at the confluence of Sandy Creek and Martin's Creek. However, these facilities are relatively small and the impact of this energy consumption on the planning area should be small if not negligible.

Energy consumption for the operation of the expanded Nutbush Creek plant of Alternative C will result chiefly from the use of the raw sewage lift station and the diffused aeration system. Additional electrical energy will be required for operating the two new pumping stations at the Red Bud Creek plant site and at the confluence of Sandy Creek and Martin's Creek. However, these treatment facilities are relatively small and the impact of this energy consumption on the planning area should be small if not negligible.

4. Transportation

During construction of the treatment facilities, large equipment will be required for earth work and for movement of heavy construction equipment. Additional traffic will be introduced for the movement of process equipment and construction labor and materials to and from the construction site. However, this traffic will be temporary and of a local nature and should produce only minor impacts.

Construction of major interceptors and collectors will not only induce traffic for construction equipment but will also obstruct private traffic in the urban areas. However, this traffic problem should exist for only a short time.

The operation of the treatment facility or facilities will generate truck traffic for the removal and disposal of dried sludge and grit. Movement of this traffic will generally be to and from the existing landfill site at a rate of several (2 to 5) vehicles per day and should produce a negligible impact. Trucks utilized at the Nutbush Creek plant will travel on Highway 39. Trucks utilized for waste disposal at the Sandy Creek site will travel FM 1523 to FM 1533 and finally north to Highway 39.

5. Community Facilities and Services

The population growth directly produced by the construction of a wastewater treatment facility will have a very small impact on community facilities and services. The present school systems, hospitals, fire and police departments, and recreational facilities will easily accommodate the small amount of growth. The peak population growth will occur during the construction phase when 30 to 40 families could possibly move to the Henderson area. The children of school age can be readily accommodated by the existing school system, which is not overcrowded. The hiring of one or two new teachers, at most, may be required. The municipal services and facilities should also easily accommodate the small increase in demands from this number of families.

The secondary growth that is induced by the facility could possibly bring about a large enough population growth to strain the present municipal facilities. If industrial growth is large, new plans must be rapidly made for enlarging and increasing community facilities and services. Current population projections show very small increases in population in the future, and thus few or no new facilities are planned. Additions to several schools are now being completed; however, no new schools are planned. A fairly large industrial growth would bring large population increases as well as increased demands for health services, fire and police protection, and recreational facilities which are not currently available. Any such growth, however, will be several years in coming, so that long-range planning for such an eventuality should resolve many of the problems before they become serious.

6. Other Projects, Programs, and Efforts

Each alternative will affect on-going federal, state, or local projects. Alternative A will generate some concern among area citizens (unsupported by this assessment) regarding the integrity of the new regional water supply on Kerr Reservoir. In addition, Alternative A will involve the Advisory Council on Historic Preservation in the decision-making process, owing to the potential for adversely affecting Laurel Mill, a National Register site.

Alternative B will also affect the Advisory Council on Historic Preservation for the same reason as Alternative A, but concerns will be larger.

Alternative C will particularly generate concern among area citizens about the integrity of the regional water supply; this impact is considered significant because the assessment indicates such concerns have some factual basis unless phosphorus is removed from the wastewater.

VI. ADVERSE IMPACTS WHICH CANNOT BE AVOIDED AND AVAILABLE MITIGATING MEASURES

A. General

For each environmental area discussed in Chapter V, certain measures can be adopted and implemented that will lessen the degree of impact. Most of these measures can be implemented by the applicant, the engineering firm, and the construction firm. They are comprised of policy decisions and physical actions that can be incorporated into facility design features, construction methods, personnel training, operating procedures, inspection and maintenance, and good engineering practices. In the first part of this chapter, the most significant of these mitigating measures are discussed.

Following the summary of mitigating measures, the environmental and economic costs of the alternatives with mitigating measures have been re-evaluated and ranked. These rankings, in terms of Figures of Merit and dollars, enable direct comparison to analogous rankings in Chapter III of this EIS. Such comparisons provide an evaluation of cost-effectiveness of these mitigating measures, both among the alternatives and between uncontrolled and mitigated conditions for an alternative.

B. Unavoidable Impacts and Mitigating Measures

1. Natural Environment

a. Air Quality

No adverse air quality impacts will occur during the construction or operational phases of Alternatives A, B, or C.

Fugitive dust at the construction site of the Sandy Creek and Nutbush Creek waste treatment plants can be avoided by frequent watering of the construction site, including unpaved access roads.

b. Odor

During extreme operating conditions, odors may emanate from both the Nutbush Creek and the Sandy Creek plants. The probability that these odors may affect residential areas is relatively small since prevailing winds are favorable during the period most likely to be associated with odor production. During a small percentage of time, however, the Nutbush Creek plant of Alternatives A and C, due to its anaerobic sludge system, may be a source of community complaints, especially after future growth of the population in the immediate vicinity of the STP. For these reasons, a two-stage, packed-column fume scrubber, employing a vigorous oxidizing agent for chemical treatment of the malodorous constituents, is proposed for the Nutbush Creek STP in Alternatives A and C. The scrubber will treat odors from both the digesters and the open sludge transfer system. This odor treatment facility is efficient, relatively inexpensive to install and operate, and easy to maintain.

c. Noise

The major impact of noise will occur during construction phases and the degree of effect will depend heavily upon population density and proximity of human habitation to noise sources. Residences within about five hundred feet of construction activity are expected to be subjected to noise intrusion during daytime hours that will be of sufficient strength to be a source interference with normal human activity. Such interference will likely be limited to no more than one-month duration for any single residence or receptor.

The impact of noise from construction activity and equipment can be mitigated by proper maintenance of operating equipment and installation of noise attenuating devices. Dozers, backhoes, and cranes are major noise sources, and modern exhaust muffling equipment will significantly reduce levels of radiated noise from these sources. Techniques developed in the mining industry (US-373) provide a means of reducing rock drill noise levels. Reductions of 6-7 dBA are possible with muffler and barrier.

Noise emissions from acoustically untreated diffuser aerators could cause adverse human reaction within 1,000 feet of the plant site. Control measures for reducing levels of noise radiation include enclosure of motors and pumps, enclosure or acoustical lagging of control valves, and acoustical lagging of all above-ground high-pressure piping.

d. Geology

A small amount of drilling and blasting of very resistant rock will be required at the Nutbush Creek site in Alternatives A and C and at dispersed points along the new sewers' length in all three alternative systems.

Drilling and blasting will be restricted to daylight hours to minimize disturbance to non-business activities. Most of the sewer length is distant from housing. Less than five percent of the length of the rights-of-way probably will require blasting for excavation.

e. Soils

The increased discharge to Nutbush Creek in Alternative C probably will slightly increase the long-term sediment yield of this stream and its sediment contribution of Kerr Reservoir. For Alternatives A and C, some additional short-term siltation in Nutbush Creek related to construction run-off on easily erodible soil is probably unavoidable. The growth of the Henderson area stimulated by the wastewater treatment facilities will commit several thousand acres of land to urban and suburban activities; this land may be more suitable for agricultural or other pursuits. Increased urbanization will also result in increased erosion and sedimentation due to higher runoff rates in storm events.

Erosion and sediment control measures are available for eliminating (Alternative B) or reducing (Alternatives A and C) the soil loss (EN-101). The first and most important of these measures is the timely incorporation of non-structural and structural control measures into the site planning and design phase. These measures include:

- avoidance of construction on areas of steep slope,
- surface roughening,
- diversion of runoff from adjacent, undisturbed areas,
- use of vegetative buffers, especially grasses and legumes, for stabilization and sediment trapping by vegetative filtering,
- use of detention or "dry" basins.

The Sandy Creek site has a natural vegetative buffer that will be left undisturbed to protect the creek against siltation. The sewer rights-of-way run parallel to the creeks and are located several tens of feet from the streams. This location provides a natural buffer against siltation. For all alternatives, an erosion and sedimentation control plan must be prepared. The plan should stipulate what measures are to be employed at various locations and what performance or efficiency is expected. The plan's must be approved by the North Carolina Sedimentation Control Commission.

f. Water

The increase in stream discharge downstream of the outfall and resultant fluctuations in this flow are unavoidable. For Sandy Creek, the increased discharges will usually be masked by natural flows which are larger than the discharge rates. Alternative B may produce noticeable fluctuations in flow, which may unavoidably promote bank instability. Secondary impacts related to urban hydrology are largely unavoidable; streamflow in the uppermost portions of all three watersheds will tend to be more flashy due to increased impervious areas, and low flows will be reduced due to less ground-water recharge. Reduction in low flows may only apply to Nutbush Creek, and these low flows are already virtually zero; no adverse impact on waste assimilation is probable.

For proposed discharges to Sandy Creek in Alternatives A and B, nutrient levels will be unavoidably increased and will promote algal growth and probably growth of aquatic weeds especially in lakes or large pools for several tens of miles downstream of the outfall. For Nutbush Creek, the nutrient loads in proposed Alternatives A and C will threaten water quality in the upper reach of Kerr Reservoir, substantially contributing to or causing its eutrophy. Alternative C will also substantially contribute to long-term water quality degradation in the vicinity of the new regional water supply system, although Alternative A evidently will not result in this impact. These water quality impacts related to eutrophication in Alternatives A and C are avoidable through the use of a phosphorus removal system at the Nutbush Creek STP. In view of the importance of Kerr Reservoir to the region, this additional unit process is therefore proposed as a cost-effective mitigating measure for both Alternatives A and especially C. Phosphorus removal will essentially insure a phosphorus-limited condition throughout the Nutbush area; the Larsen-Mercier analysis presented in Section V.B.1.f.(2) indicates that this unit process will promote rejuvenation of the lake to an oligotrophic state, improving the water quality of the lake and providing a very large buffer against future degradation of water quality from other sources. With phosphorus removal, Alternatives A and C should be essentially equivalent to Alternative B in improving the water quality of Kerr Reservoir, particularly in the upper reaches of the arm above the Highway 1308 bridge.

Urbanization encouraged by implementation of any of the three alternatives will unavoidably degrade the quality of water in the upper Nutbush, Sandy, and Red Bud/Ruin Creeks.

g. Land/Water Interface

A small increase in the siltation of Nutbush Creek backwater of Kerr Reservoir is unavoidable in Alternatives A and especially C and may contribute to shoaling of this part of the reservoir in time. A 30-foot buffer will be required between the edge of the construction right-of-way and all stream banks, except where stream crossings are necessary.

h. Biology

Impacts to biota of the study area are, to a large degree, unavoidable, but most are short-term or of minor ecological significance. A substantial exception to this statement is the unavoidable long-term beneficial impact on water quality of all alternatives. Amelioration of water quality and removal of stress from the ecosystem of Nutbush Creek will result from all alternatives. If phosphorus removal is employed, the same benefits will accrue to Kerr Reservoir.

The discharge under Alternatives A and B to Sandy Creek, which is not now highly stressed, is perhaps the most important unavoidable adverse impact on biota, due principally to the nutrient loadings. While advanced waste treatment (i.e., nutrient removal) would obviate this problem, this treatment is not deemed cost-effective; the chief result of introducing the treated effluents of Alternatives A and B to Sandy Creek will be an increase in productivity if the creek can assimilate the nutrients. Increased productivity will probably be reflected principally as some increase in aquatic plant growth, particularly algae in the shallows of ponds.

Sources of biological impact and potential mitigative measures are summarized in Table VI-1.

TABLE VI-1

SUMMARY OF BIOLOGICAL IMPACT PARAMETERS AND CORRESPONDING MITIGATING MEASURES

Unavoidable Biological Impacts	Potential Mitigative Measures
Construction Disturbance	
1. Noise	Muffle engines of heavy equipment
2. Exposed Soil and Erosion	Re-vegetate exposed areas quickly
3. Siltation	Re-vegetate exposed areas quickly and employ other methods as outlined in the state's Rules for Erosion and Sediment Control such as diversion ditches and catch basins, and 30-foot buffer between right-of-way and stream bank.
4. Natural vegetation loss	Use as narrow pipeline easements and as small construction sites as possible
Operational Disturbance	
1. Noise	Install noise-deadening material around noise sources where possible
2. Odors	Operate treatment facility efficiently to avoid upset conditions
3. Effluent discharges: High BOD, TSS, and Low DO	Operate treatment facility efficiently to stay within BOD-5 and TSS standards. Use temporary holding ponds to store untreated sewage during upset or overload conditions to avoid bypassing into creeks.
Nuisance algal growth	Employ nitrogen and phosphorus nitrogen and phophorus removal to keep nutrient loadings very low.

2. Man-Made Environment

Adverse impacts and mitigative measures for the population and economy and the economic geography of the study area are summarized in the following sections.

a. Population and Economy

The population and economy of the area should undergo no substantial adverse changes as a result of the construction of any alternative system. Due to a complex combination of factors, the existing conditions of declining rate of population growth, high unemployment, and rather stagnant economy are not likely to be directly affected by either construction or operation of any alternative. The present moratorium on industrial expansion and relocation in Henderson would be lifted upon implementing any alternative, and this impetus could spur industrial growth in the area which would tend to reverse the existing trends. The tendency to attract new industry or industrial expansion is deemed an unavoidable beneficial secondary impact in this context.

b. Economic Geography

(1) Land Use

Six unavoidable adverse impacts and comments including mitigative measures are listed below:

1. Visual impact of facilities	The Sandy Creek site in Alternatives A and B will be surrounded by existing forest lands. Retention of the forested area will block the facility from public view. The expansion of facilities at Nutbush Creek site in Alternatives A and C is unlikely to evoke more adverse impact than now exists.

2. Visual impact of cleared line right-of-way	Cleared line right-of-way will have to be maintained as open space. Staggering of the line could eliminate any long lines of cleared land in unaesthetic strips.
3. Commitment of existing farm land to facility and line right-of-way use	Neither of the plant sites will have to be cleared; therefore, the only significant site change will be construction of building and other engineering structures.
4. Potential impact on surrounding property values	Property values will tend to return to normal once construction has ended and actual impacts are assessed by local residents.
5. Increased use of community facilities, such as recreation, transportation, schools, etc.	Henderson and the 201 Planning Area will continue to grow regardless of the addition of the new facility, although not as rapidly, due to the availability of septic systems. Therefore, increased use of community facilities will occur even under a "no action" alternative. Neither scale of growth appears out of range for service by the existing facilities.
6. Disruption of community facilities due to construction	There is no mitigating measure to disruption as a result of construction.

(2) Archaeological and Historical

It is anticipated that both Alternatives A and B will potentially result in two unavoidable adverse impacts; an incremental increase in siltation at Laurel Mill Pond and a small increase in aquatic growth at Laurel Mill Pond. Each of these is discussed below.

Siltation: A very small increase in the amount of siltation within the pond at Laurel Mill will occur due to increased flow of the receiving stream. This is not considered to be a serious problem, especially relative to siltation caused by natural causes.

Aquatic Growth: There is a potential for an increase in nutrient loading of the water reaching Laurel Mill Pond due to the wastewater discharge. This may cause a small increase in the growth of algae and/or rooted aquatic plants in the pond. Possible utilization of nutrients by biota upstream of the mill pond serves to diminish the impact and is, therefore, a mitigating measure. Insufficient data prevent the adequate assessment of this possibility. However, on the basis of other experience, this aspect does not appear to be of large concern.

No adverse impacts on historical, cultural, or architectural resources are anticipated from the implementation of Alternative C. As with Alternatives A and B, an assessment of the unavoidable adverse impacts to archaeological resources, based on a professional archaeological survey, will be included in the Final Environmental Impact Statement.

(3) Resource Use

Since the major portion of the construction equipment for construction of Alternatives A, B, or C will be purchased from outside the area, essentially no adverse impact on local material resources will be imposed. Electrical energy consumption for the operation of the treatment facilities and pumping stations, although significantly larger than that presently required for operation of the wastewater treatment facilities, will be relatively small and any adverse impact should be negligible.

C. Re-evaluation of Costs

1. Environmental Costs

As described in Chapter III, the environmental costs were ranked according to a Figure of Merit derived from citizen input and professional judgement. The multidisciplinary professional team subsequently re-evaluated the three alternatives by considering residual adverse impacts after adoption of the measures described in Section IV.B. above. The results of this re-evaluation, based on more detailed information but the same rationale as used previously, are compared to the unmitigated impact Figure of Merit (F.O.M.) for the three candidate alternatives in Table VI-2.

TABLE VI-2

COMPARISON OF ALTERNATIVES' FIGURE OF MERIT BEFORE AND AFTER IMPLEMENTATION OF MITIGATIVE MEASURES

Alternative Systems	FOM Based on Unmitigated Impact	FOM After Adoption of Mitigative Measures	Difference
A	4.56	5.33	+0.77
B	5.26	5.79	+0.53
C	4.33	4.92	+0.59

The alternatives maintain their prior ranking, although they are beneficiated by the mitigating measures by different amounts. Alternative A is improved the most, and B and C are increased in environmental "goodness" by a lesser, approximately equal amount. All of these alternatives with mitigating measures are considered environmentally sound, but clearly Alternative B is the most environmentally acceptable.

The mitigative measures have a more pronounced effect on the "Red Flags" for the systems than on their overall rating. The changes are shown below:

Alternative Systems	Red Flags Without Mitigative Measures	Red Flags With Mitigative Measures
System A	1. Siltation and Turbidity (2) 3. Natural Streamflow 4. Natural Vegetation 5. Undisturbed Ecosystems 6. Agricultural Land Use 7. Water-oriented Recreation 8. Federal Projects and Programs	1. Natural Streamflow 2. Agricultural Land Use
System B	1. Short-Term Noise 2. Siltation and Turbidity (2) 4. Natural Streamflow 5. Natural Vegetation 6. Undisturbed Ecosystems 7. Agricultural Land Use 8. Water-oriented Recreation 9. Historical Sites 10. Traffic (2) 12. Federal Projects and Programs	1. Natural Streamflow 2. Agricultural Land Use

Alternative Systems	Red Flags Without Mitigative Measures	Red Flags With Mitigative Measures
System C	1. Odor Problems	1. Natural Streamflow
	2. Short-term noise	2. Agricultural Land Use
	3. Water Quality of Kerr Reservoir	
	4. Siltation and Turbidity (2)	
	6. Algal Growth/Aquatic Plant Excess/Sludges	
	7. Natural Streamflow	
	8. Natural Vegetation	
	9. Undisturbed Ecosystems	
	10. Agricultural Land Use	
	11. Water-oriented Recreation	
	12. Traffic	

The listing above indicates that all three alternatives suffer from the same types of major impacts and to the same degree. The low flows of all receiving streams will be substantially altered by the wastewater discharges, reflecting the unavoidable necessity of discharging wastewater to small headwater streams. It is significant that other adverse impacts that could accrue in such hydrologic settings (particularly water quality problems) are not of large concern within the proposed systems. The other major adverse impact present in all three alternatives is the secondary effect of transforming considerable, existing agricultural land use in the Sandy Creek basin that is near an urban center to residential/industrial land use without comprehensive planning.

2. Economic Costs

Most mitigating measures that may be employed have insignificant net cost differentials among the three alternatives. No attempt was made to assign incremental costs, if any, to most mitigating measures; therefore, the costs given in this section, while internally consistent, may not reflect the actual construction and operating costs of a system at a particular site. Nevertheless, these costs usefully serve as a comparative index.

Two mitigating measures described in Section VI.B. for odor control and phosphorus removal at the Nutbush Creek STP of Alternatives A and C will significantly affect cost evaluations among the alternatives. A summary of the economic costs (treatment costs, present worth, and user charges) of the three systems, both with and without mitigating measures, is given in Table VI-3.

From these data, it appears that Alternative C is the most economically cost-effective alternative, even with the additional costs of mitigating measures. Alternative B probably exceeds the funding capability of the City of Henderson if a state grant is not available for the project. Alternative A without mitigating measures is perhaps the only economically viable option to Alternative C with or without mitigating measures, but it is clearly inferior to both from a cost-efficiency standpoint.

TABLE VI-3

FINAL SUMMARY OF ALTERNATIVE COSTS

System	Total Capital Cost (Millions $)	Capital Cost[1] to City (Millions $)	Operation and[2] Maintenance (Thousands $/yr)	Total Treatment Cost ($/MG)	Present Worth (Millions $)	Annual[1] User Charge ($/Person/Yr)
WITHOUT MITIGATIVE MEASURES[3]						
A	7.049	1.897/1.039	388.6/271.2	747	11.291	19.00/15.70
B	9.076	2.434/1.372	324.2/226.3	832	12.455	19.10/14.80
C	6.291	1.700/0.935	281.0/196.1	618	9.325	15.00/12.00
WITH MITIGATIVE MEASURES[4]						
A	7.295	1.956/1.068	431.7/301.3	795	11.934	20.50/17.10
B	9.076	2.434/1.327	324.2/226.3	832	12.455	19.10/14.80
C	6.707	1.804/0.987	358.7/250.4	703	10.587	17.70/14.60

[1] Supplemented by federal funds only/supplemented by both state and federal funds.
[2] Total O&M Cost/Municipal (non-industrial) O&M Cost.
[3] From Tables III-7 and III-8.
[4] Includes phosphorus removal and odor control at Nutbush Creek STP only.

VII. COORDINATION WITH OTHERS

During the course of developing the EIS, much information and assistance were provided by various federal, state and local agencies and interested members of the community. Those governmental offices that were contacted and the nature of their contribution to the preparation of this EIS are listed on the pages that follow.

The following offices and agencies participated directly in the preparation of this Draft EIS:

EIS Preparation Branch, Region IV
U.S. Environmental Protection Agency
Atlanta, Georgia

Environmental Coordinator
North Carolina Department of Natural
and Economic Resources
Raleigh, North Carolina

Division of Environmental Management
North Carolina Department of Natural
and Economic Resources
Raleigh, North Carolina

North-Central Regional Field Office
North Carolina Department of Natural
and Economic Resources
Raleigh, North Carolina

HENDERSON EIS CONTACTS

CONTACT	PURPOSE
Chief and Staff Environmental Resources Branch Corps of Engineers Wilmington, N.C.	Data on morphometry water quality, and other information on Kerr Reservoir; flood plain of Tar River
Water Quality Specialist Environmental Resources Branch Corps of Engineers Wilmington, N.C.	Larsen-Mercier analyses performed on Nutbush area
State Director and Hydrology Staff Water Resources Division U.S. Geological Survey Raleigh, North Carolina	Flow characteristics of streams; gaging station data and other publications
Hydrologist, Ground Water Section Dept. of Natural and Economic Resources State of North Carolina Raleigh, North Carolina	Hydrogeologic setting and ground water resources of area
Curator of Aerial Photos Agricultural Stabilization and Conservation Service Raleigh, North Carolina	Aerial photographs
Field Scientists Louisburg Field Office Soil Conservation Service Louisburg, N.C.	Soil association maps of 3-county area; detailed soil maps of STP sites and interceptor routes
State Soil Scientist and Staff Soil Conservation Service Raleigh, N.C.	Physical properties related to erodibility of soils in the study area
Director, Surface Water Studies Texas District Water Resources Division U.S. Geological Survey Austin, Texas	Statistical summary of streamflow at selected points in North Carolina
Dept. of Environmental Sciences School of Public Health University of N.C. - Chapel Hill	Water quality of Kerr Reservoir, existing stresses and eutrophication potential; Vollenweider concept for assessing eutrophy

CONTACT	PURPOSE
Dept. of Soil Science North Carolina State University Raleigh, N.C.	Land application practice in N.C., capability and limitations of soil phases in the study area to support land application of effluents
Office of the Mayor Henderson, North Carolina	Various information about the history, plans and programs of Henderson
City Managers Office Henderson, N.C.	Background and history of the 201 project and various related activities
U.S. Dept. of Agriculture Soil Conservation Service (local offices in Louisburg and Henderson)	Soils of the study area
North Carolina Agricultural Extension Service (Vance, Warren, and Franklin counties)	Present, post and future expected crops and yields in the study area
North Carolina Wildlife Resources Commission Raleigh, N.C.	Animals and plants of the area, conservation programs and post hunting and fishing harvests
N.C. Div. of Forest Resources DNER Raleigh, N.C.	N.C. forest resources and yields
Louisburg College Louisburg, N.C.	Native plants of the area and endangered species
U.S. Fish & Wildlife Service Raleigh, N.C.	Wildlife of the area and endangered species
Agricultural Stabilization and Conservation Service Henderson and Raleigh, N.C.	Agricultural crops and yields of study area

CONTACT	PURPOSE
State of North Carolina Archives and History Division Survey and Planning Raleigh, N.C.	North Carolina archaeological and historical review requirements
State of North Carolina Dept. of Archaeology Raleigh, N.C.	Archaeological resources of study area
State of North Carolina Dept. of Natural and Economic Resources Division of Community Assistance Raleigh, N.C.	Studies connected with 701 HUD funds and other local studies
State of North Carolina Dept. of Natural and Economic Resources Air Quality Section Raleigh, N.C.	Air quality information on Vance County
State of North Carolina Office of Local Recreation Raleigh, N.C.	Existing and proposed recreational facilities in the Vance County area
U.S. Department of Housing and Urban Development Federal Flood Insurance Office Atlanta, Georgia	Flood plain studies
Housing and Urban Development State Office Chief Planning Division Program Management Section Greensboro, North Carolina	Current activities in the study area
City of Henderson Planning and Community Development Department Henderson, N.C.	Local planning
Region K. Council of Governments Henderson, N.C.	Local plans and forecasts
Henderson/Vance County Planning Commission Henderson, N.C.	Local planning activities
Vance County Historical Society Henderson, N.C.	Local historical sites

CONTACT	PURPOSE
Henderson Chamber of Commerce Henderson, N.C.	Local industry, business, and history
Vance County Board of Education Henderson, N.C.	Educational facilities of study area
Henderson/Vance County Director of Recreation Henderson, N.C.	Recreational activities, facilities and programs
County Tax Department Henderson, N.C.	Area tax information
State of N.C. Local Administrator of Housing and Urban Development 701 Funds for Henderson Area Henderson, N.C.	Current studies of Henderson area
State of North Carolina Dept. of Natural and Economic Resources Library Raleigh, N.C.	Various reference materials
State of N.C. State Highway Comm. Div. of Planning Raleigh, N.C.	1975 traffic counts for Vance Co.
Reading and Resources Room Atmospheric Science Group University of Texas at Austin Austin, Texas 78712	Rainfall frequency data for various durations and return periods
National Climatic Center Asheville, North Carolina	Climatological information
State Historic Preservation Officer N.C. Dept. of Cultural Resources Raleigh, N.C.	Consultation concerning Laurel Mill
Archaeological Section N.C. Dept. of Cultural Resources Raleigh, N.C.	Project alternatives with respect to archaeological resources

CONTACT	PURPOSE
Archives and History Div. N.C. Dept. of Cultural Resources Raleigh, N.C.	Historical resources of study area
Research Lab. of Anthropology Univ. of N.C. at Chapel Hill Chapel Hill, N.C.	Archaeological records for project area

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